TELESCOPE MAKING 27

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The magazine *for*, *by*, and *about* telescope makers!

Spring 1986

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The magazine *for, by,* and *about* telescope makers!

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Cover: Interference pattern for a Schmidt Corrector plate. Photo by Michael J. Harlow.

Editorial

> Telescope Kit: Two glass disks (1:6 ratio) tempered pitch, 8 assorted abrasives, rouge, instructions, free aluminized diagonal. Cost $5.50. Aluminizing 6″ diameter for $2.50.

Sounds like an April Fool's joke, but those were real prices 38 years ago. Similar prices were advertised 50 years ago, when I finished my first telescope. This, I believe, is the most outstanding change I have witnessed in the passing years: the "Poor Man's Telescope" of Russell W. Porter and "Unk" Ingalls is no more! I never thought I would see the time when the cost of a beginners 6" telescope kit plus aluminizing would cost more than a finished commercial mirror. Recently a former telescope making instructor told me he had discontinued the class because he could no longer justify asking his students to pay to make a mirror when they could buy a finished one for less money. It is truly a sad state of affairs.

Since this last was the fiftieth year since I completed my first telescope, I decided to attend as many large telescope making meetings as possible to feel the pulse of telescope making in the United States. In one summer, between Memorial Day and mid-September, I was able to attend Riverside, the League meeting in Tucson, Stellafane, and Astrofest.

My observation is that on the West Coast there seem to be a lot of large-aperture trailer-mounted instruments. Such telescopes emphasize today's interest in Deep-Sky wonders and need to be taken out of the light and smog

Editorial

Perceptive readers (what other type do we have?) have already noted that another issue of Telescope Making has made it into the world. With Halley Fever dying down, the Voyager/Uranus and Giotto/Halley flybys over and duly presented to the world, and the year's Big Corporate Administrative Meeting over and done with, Telescope Making should receive a bit more of my attention. To be perfectly honest with you, I don't expect TM#28 to get done quite on schedule, but things ought to be leveling out by the time TM#29 is ready to roll. I want to thank you for your patience and understanding. Nobody enjoys putting out a magazine that's three months late, and nobody who receives a magazine three months late is truly happy either. You should be aware that your support has made it possible to continue this magazine.

I agree with most of the points that Bob makes in his editorial. I think, though, that we dyed-in-the-wool glass pushers ought to be quite cautious in promoting optical work as an essential part of telescope making. Porter made it abundantly clear in that seminal article, "The Poor Man's Telescope," published in Scientific American in 1921, that the prime reason for getting into making your own mirror was that professionally made telescopes were too expensive for the average man in the street back then. Glass pushing really caught on during the Depression when lots of bright people had more time than they had cash.

Today the situation has changed. We simply cannot ignore that finished mirrors have become less expensive than a kit plus aluminizing. To insist that someone newly interested in building a telescope grind his own first mirror, and then, adding insult to injury, to criticize that mirror as "small" in today's amateur world, is asking a lot. To force the issue will either accomplish little more than drive people away from amateur astronomy altogether, or make them throw up their hands and buy a finished scope.

A gentle approach to mirror making works pretty well. I've given a number of talks based on my book, *Build Your Own Telescope*, which gives only two chapters to optical work and ten chapters to telescopes and telescope building. I set out to acquaint the book's readers with optical work but did not insist optics be central.

Well, the good news is that after such a talk, a few people always ask about making the optics as well as building the telescope. That's the way I'd like it to be: the real do-it-yourself types are naturally curious and want to give glass work a try. The others have a legitimate goal: they want to construct a working telescope and get on with observing. I feel best when someone makes a choice freely, without my having to push them either way.

If Porter were born into the world of the 80s, I think he'd be delighted with the amount of amateur astronomy being done. I doubt very much he would spurn those who build telescopes rather than making mirrors. Aren't we after the same thing? And after all, as Porter himself asks in his cartoon on page 555 of ATM2, "What's a mere telescope between friends?"

Richard Berry

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pollution found in cities. I found that most of the optics were purchased, but the mounting and accessories were made by the amateur. One reason for this is the lack of a source of thick glass blanks at reasonable prices, forcing most to make thin blank mirrors from commercial sheet Pyrex. Grinding thin glass is not a task for a beginner, so these blanks limit the amateur who wishes a large aperture.

Riverside is a meeting at which commercialism is highly visible. The vendors display their wares and sell items right on the telescope field. Now, I'm in favor of having commercial exhibits at meetings so people can see first hand the quality of an item and how it is constructed. However, I am not in favor of selling at meeting, especially beside amateur exhibits. I think Riverside would be greatly improved if the meeting had one location for the amateur displays, and another location for the displays and sale of items. Separating the different attractions works for swap meets and paper sessions, and I believe would work well with the commercial displays, too.

What causes this problem is that the vendors are allowed to give away complete telescope systems as door prizes in return for being allowed to exhibit. The lure of these expensive items almost certainly makes it difficult for the convention organizers to set convention policy. Telescope makers at the convention don't have any big, expensive incentives to dangle in front of the organizing committee, so their interests, and the best interests of the RTMC, are ignored for those who give door prizes.

I'd like to assure everybody that I do enjoy the Riverside meetings and Cliff and Jackie Holmes do a terrific job. I am especially pleased to see that they continue the policy I suggested back in the early 70s of not having first, second, and third prizes, but giving merit awards in recognition of outstanding contributions to the hobby of telescope making.

Riverside also had a good number of amateur-owned commercial SCT instruments on the field, but, of course, the telescopes themselves are not eligible for awards. However, one of the most interesting parts of Riverside is the innovative accessories devised by amateurs. If the owner of a commercial instrument has made an interesting modification or accessory that will help others, this accomplishment can be recognized with a merit award.

The East Coast meeting at Stellafane is noticeably different from Riverside. This year many TMs at Stellafane had made their own optics, a considerably larger number than had done so at Riverside. Also there were fewer trailer-mounted instruments and a greater number of smaller aperture instruments. Few commercial telescopes were displayed. Those that were, were there so the owner could try them out on the wonderful skies of Vermont.

Stellafane allows no commercial exhibits. The introduction of an amateur swap table has greatly enhanced the meetings for those attending. I hope that in the future those operating the meetings would consider establishing commercial exhibits under strict guidelines. Many years ago, I was at the last Stellafane meeting at which commercial exhibits were allowed. The littering of the grounds by posters from one vendor was one of the reasons it was decided to eliminate such problems in the future.

It would be nice to be able to see accessories and handle them and even use them in the evening on a designated instrument, but with no sales permitted. Such displays would greatly enhance, in my estimation, the meeting. There are no door prizes at Stellafane, but they do have a raffle of instruments and material donated by various vendors and people, the proceeds from which go to the land fund. I would also hope that some day Stellafane will eliminate first, second, and third prize rankings and replace them with merit awards. Then everyone would be equal in helping their fellow telescope nuts.

As the "shrine" of telescope-making activities in the United States, Stellafane

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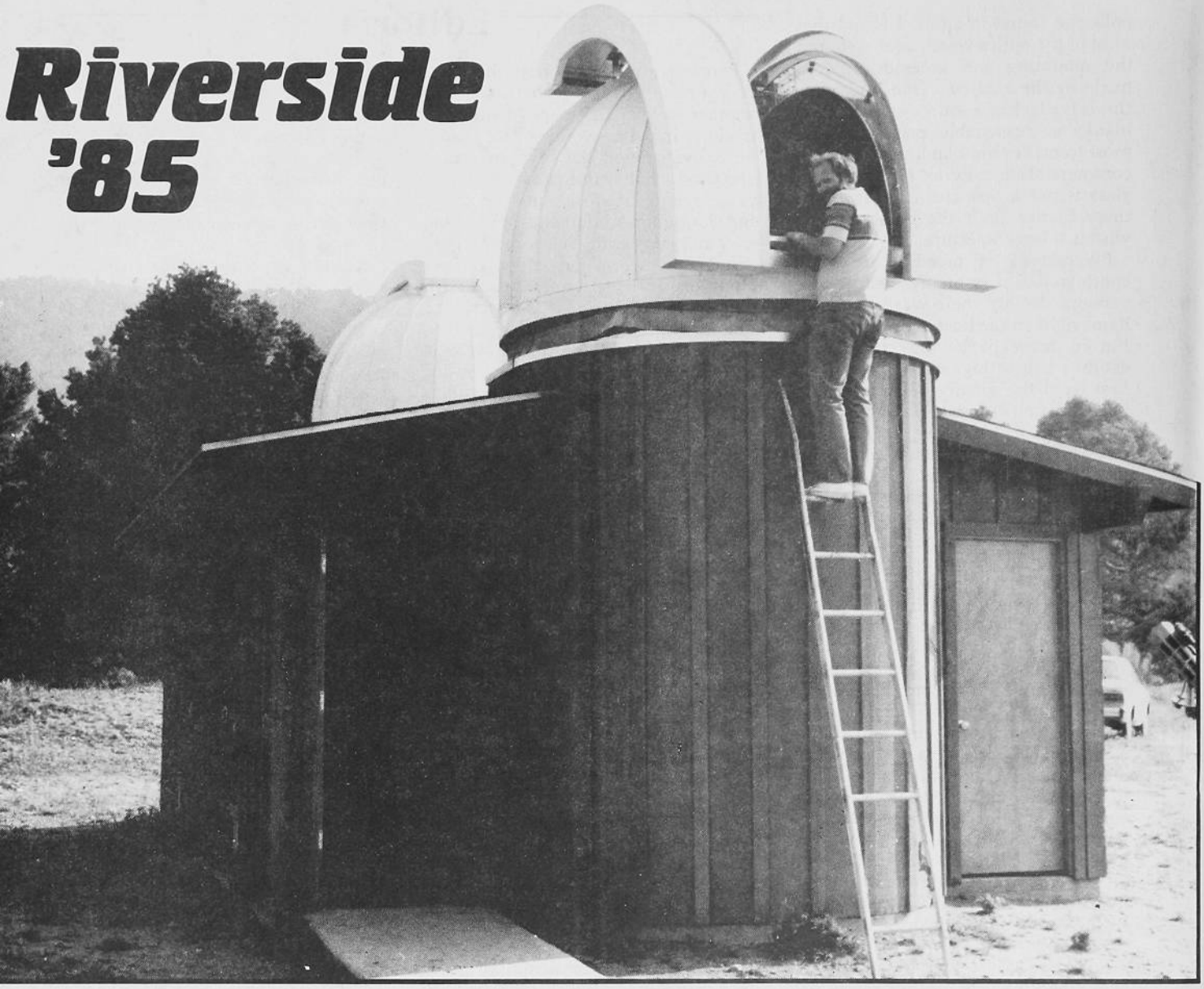
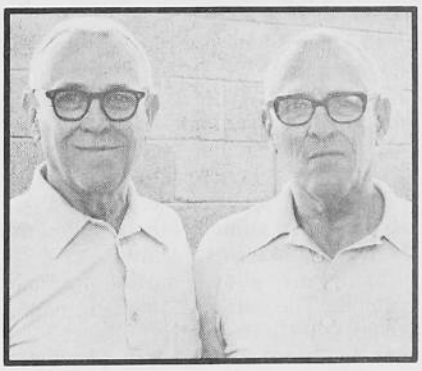
Riverside '85



The Trip

It was 6 a.m. on May 19th, and the odometer on my LeBaron wagon read 25,777 miles when I left O'Fallon, Missouri and headed for the Riverside, California meetings. If all went well, I expected to be in Amarillo, Texas in time for supper.

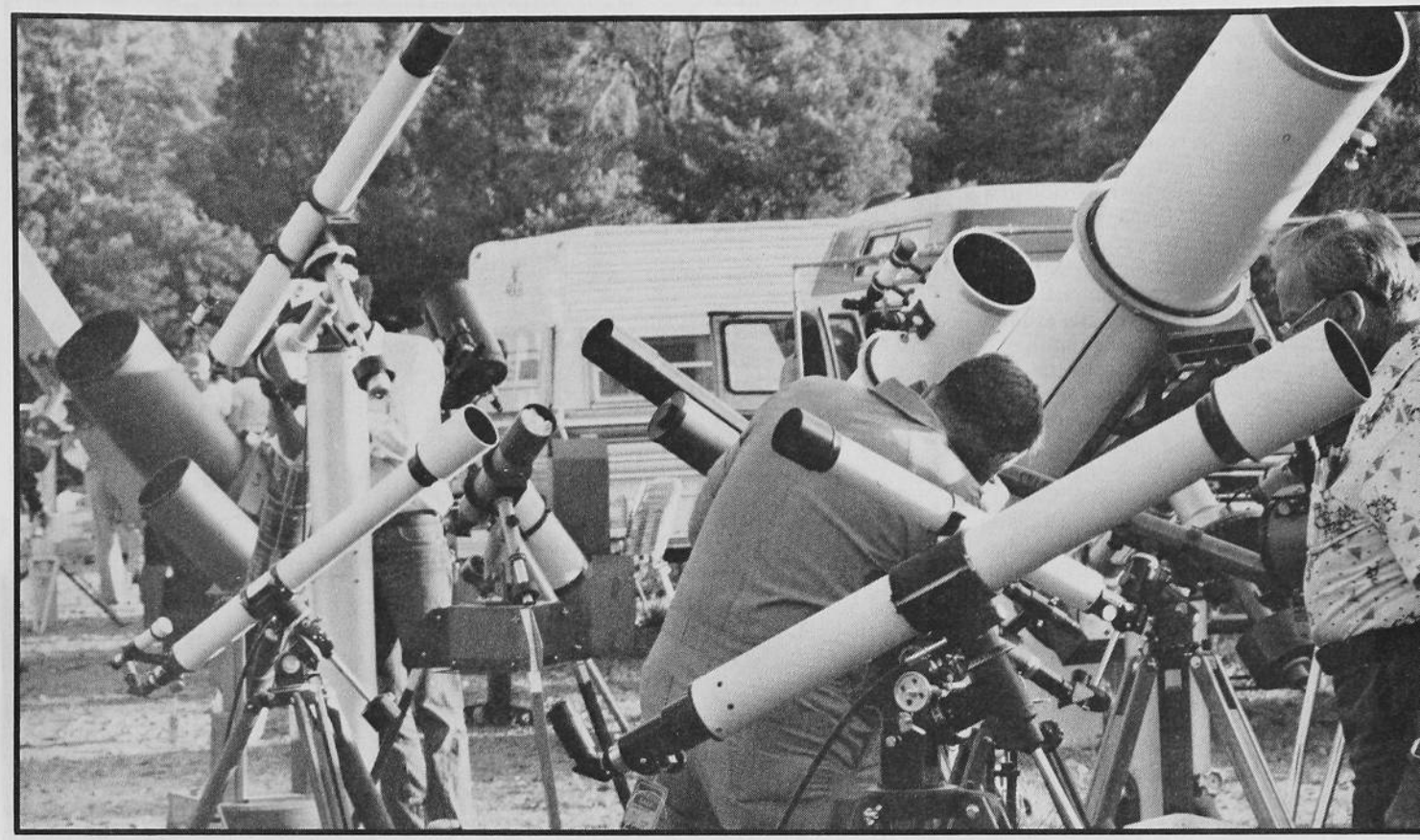
I kept awake while driving in Missouri by watching for odd town names. Eureka is well-named — sort of a vacuum of a place — not much doing there, but a few miles down I-44 is the large Six Flags Amusement Park near St. Louis. About 74 miles from St. Louis is a town where many people want to stop and sample the water. The name is painted on the water tower that supplies the town: Bourbon! About 124 miles from home, I came across one of the most unusual town names in the country. Back in the 60s an amateur had



a 12″ telescope and homemade planetarium there. Every time I see the town's name, I wonder where the rest of him is. The town: Devil's Elbow! About 25 miles farther down the road is a town that described my condition when I started out: Sleeper! As I continued down I-44 toward Oklahoma City, I found the place where old archery parts end up: Broken Arrow. Switching to I-40, I arrived at Amarillo at 8 p.m.

The next day I drove 270 miles to Albuquerque, New Mexico, where I planned to stay at my brother's until Thursday morning, so we could bug his local friends and neighbors. Now why would Robert Edward, visiting Edward Robert, want to cause so much trouble? Just look at the picture! Incidentally, this picture is purely scientific: it is living proof that nature can make the same mistake twice!

The weather for driving had been excellent up to this point, but at Albuquerque thunderstorms hit on both Monday and Tuesday afternoon. We couldn't go out, but we had a good time visiting anyway.



At 6 a.m. Thursday I headed for California. Clear, dry roads put me at Gallup, New Mexico by 9 a.m., where both the car and I were filled up, one with gas and the other with food (don't be mean and ask which is which!). I continued driving west on I-40 passing Meteor Crater and Flagstaff, home of the Lowell Observatory (where the Astronomical Society of the Pacific held its 97th annual meeting on June 22). Arriving at Barstow at 6 p.m. PDT, I saw a motel that I couldn't pass up, ASTRO, so I checked in and then walked down the street for dinner. I had driven 683 miles that day, so it was early to bed.

Since the camp information sheet listed opening to delegates at 1 p.m., I didn't rush to get up the next morning, but hunger woke me anyway. In spite of the early hour, I decided to drive up the mountains and after an easy run across the desert through the Lucerne Valley, I climbed the San Bernardino Mountains to Big Bear City. It was a good climb with some slopes of eight to eleven degrees, but the car took them easily and I arrived at Camp Oaks around noon.

A number of cars were waiting along the dusty dirt road that lead into Camp Oaks for the official opening time, but I decided to see if I could jump the gun and get in to set up my equipment and record the delegates as they arrived. Driving down the road, I found the registration tent and was cordially greeted by Richard Bean of Hesperia, California. He located my registration and meal tickets and let me enter the grounds as I had hoped. The only others around were local amateurs helping with the operation of the meetings and some leftover delegates from the IAPPP meetings which had just ended. I selected a bunkhouse close to the path, the telescopes and mess hall, unpacked my cameras, and strolled out to the telescope field. It seemed empty, but I did find some activity there.

The Scopes

I was surprised by the new, two-domed observatory building that had been erected on the telescope field. It was locked, but I quickly took pictures before the view was blocked by telescopes and campers.

The first assembled telescope I saw belonged to Wayne Johnson of Corona, California, who had mounted his 17.5″ Coulter mirror scope, with its 5″ f/5 finder, on an Omnitorial mount, or ball and socket. The thin mirror was mounted in a plywood ring with three layers of plywood in the cell with carpet between the cell back and mirror. The tube moved smoothly and he had it resting on a box to prevent the wind from moving it.

One of the newest commercial exhibits was the Byers 58 equatorial mounting with the axes designed on the principles of R.W. Porter, as presented in ATM-Book One. This mounting, like all Byers products I have seen, was a jewel of workmanship. Porter and his partner, Richard Lorber, had put much thought and work into the design which was displayed mounted with an 8″ Schmidt camera. A novel feature was the pendulum-type indicator for setting the latitude of the observing site. Although not on the display instrument, a polar alignment is optional in the polar axle.

My old friend Arthur S. Leonard arrived early and planned to display his well-known Yolo telescope. He also had a precision tester he built to increase the accuracy of making zonal readings on a mirror using a variation of the Caustic Test which he has developed. Art is the West Coast's best-known amateur telescope maker and is a delight to swap optical information with.

The commercial exhibitors were now arriving and setting up their displays and I noted a most unusual 6″ f/8 telescope among their precision equipment. Tom Hayes of Van Nuys, California had put together what one could only call the Mrs. Olson telescope: the tube was a series of Folger coffee can bodies! I wondered if the association would help

one from getting sleepy during a long nights' observing. It was a novelty, but the vignetting of the edges of the field should be heavy due to the restricted size of the can diameters.

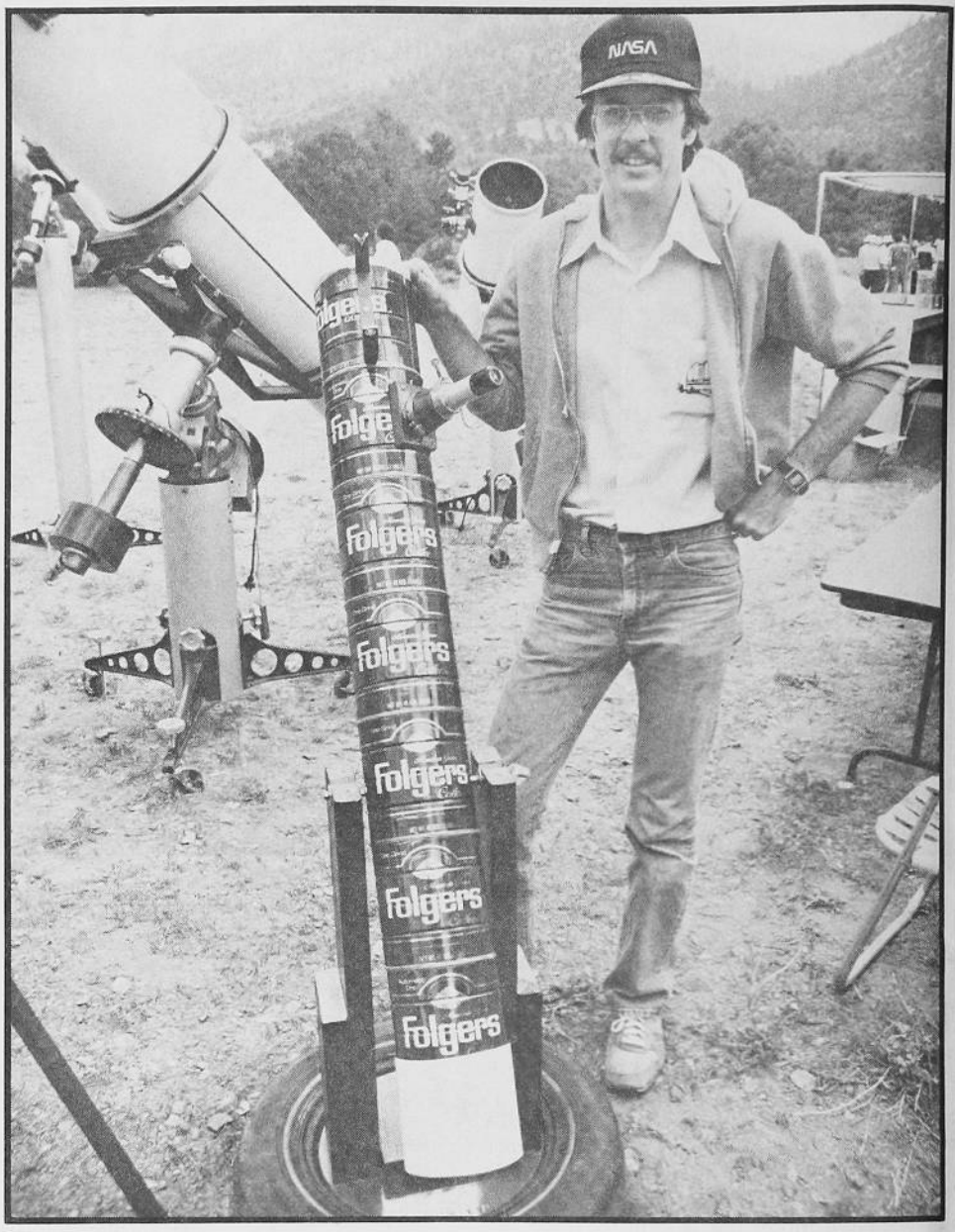
Dick Nelson, a regular exhibitor at Riverside, had his display in front of him while he relaxed in the shade of a large tree. Dick's 8″ f/8 Newtonian telescopes were a good buy years ago, until he found he couldn't compete with the new Catadioptric 8″ instruments. He is an old friend who showed me around his optical shop many years ago.

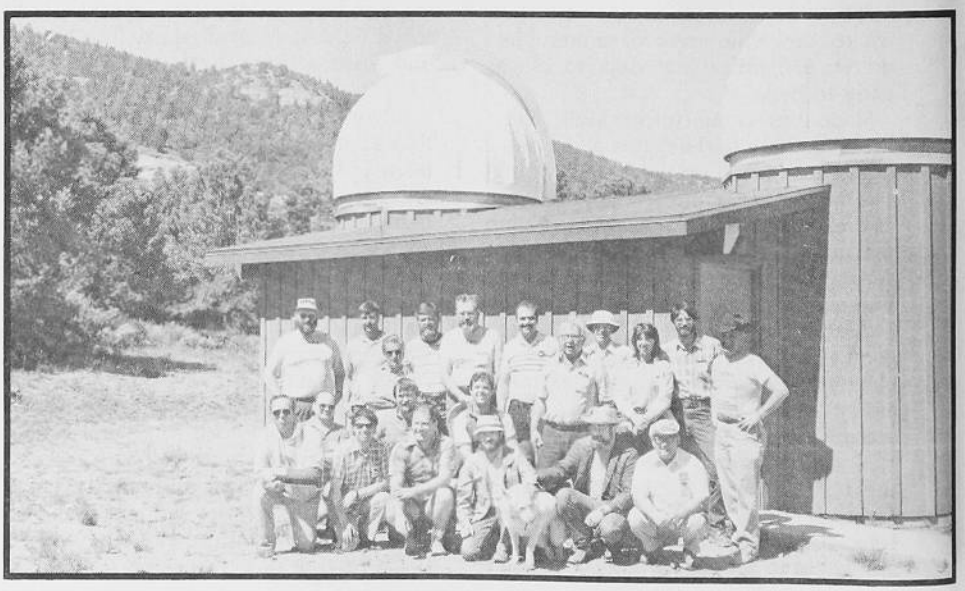
Returning to the telescope field, I found the new observatory open and went inside. One dome housed a 14″ Celestron, while the other had a 10″ Meade Newtonian. On the floor of the main building was a large Coulter Dobsonian that could be set outside as a third telescope. The novel design featured a large, open space in the center of the building at ground level. The two domes were set in a restricted, raised area that could be reached by climbing a short ladder. This arrangement restricted the number of people who could be in the dome at one time. Large paper murals covering the walls showed astronomical events. I could see that people waiting to climb the ladder might get restless, unless they could be kept busy outside with the Coulter instrument.

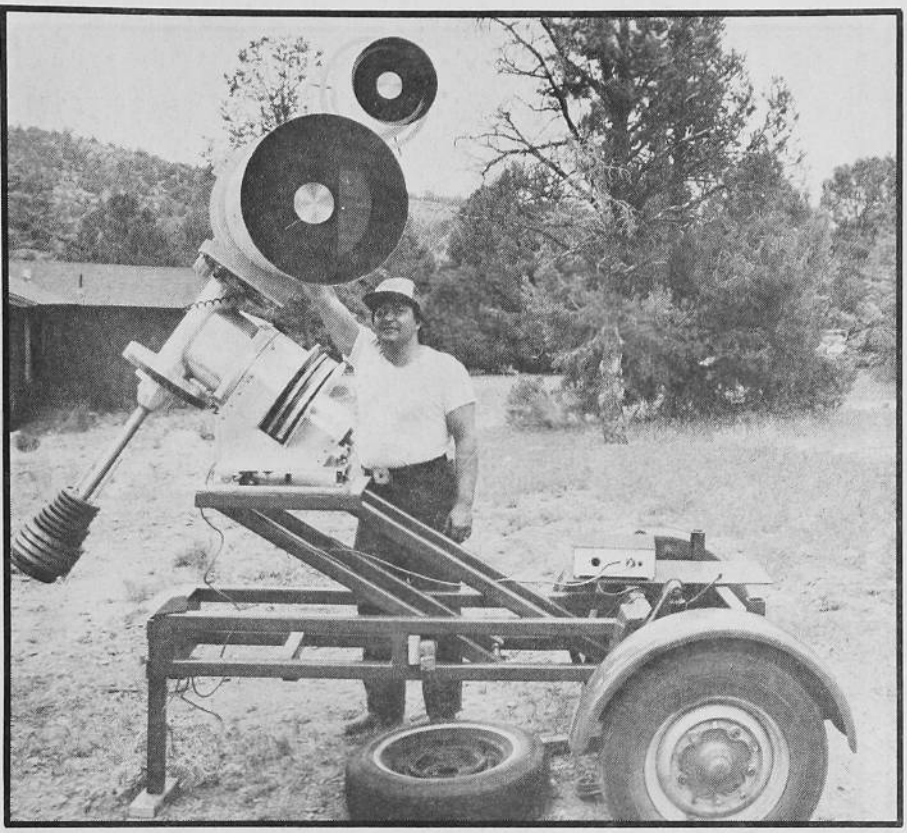
People had now spread themselves and their telescopes throughout the area, and it was time for me to explore the side paths. I was concerned about spraining an ankle because the telescope field and paths were rocky. It sure would be nice if Camp Oaks could sweep up the majority of those rocks, not only for the sake of the delegates, but the YMCA youngsters as well.

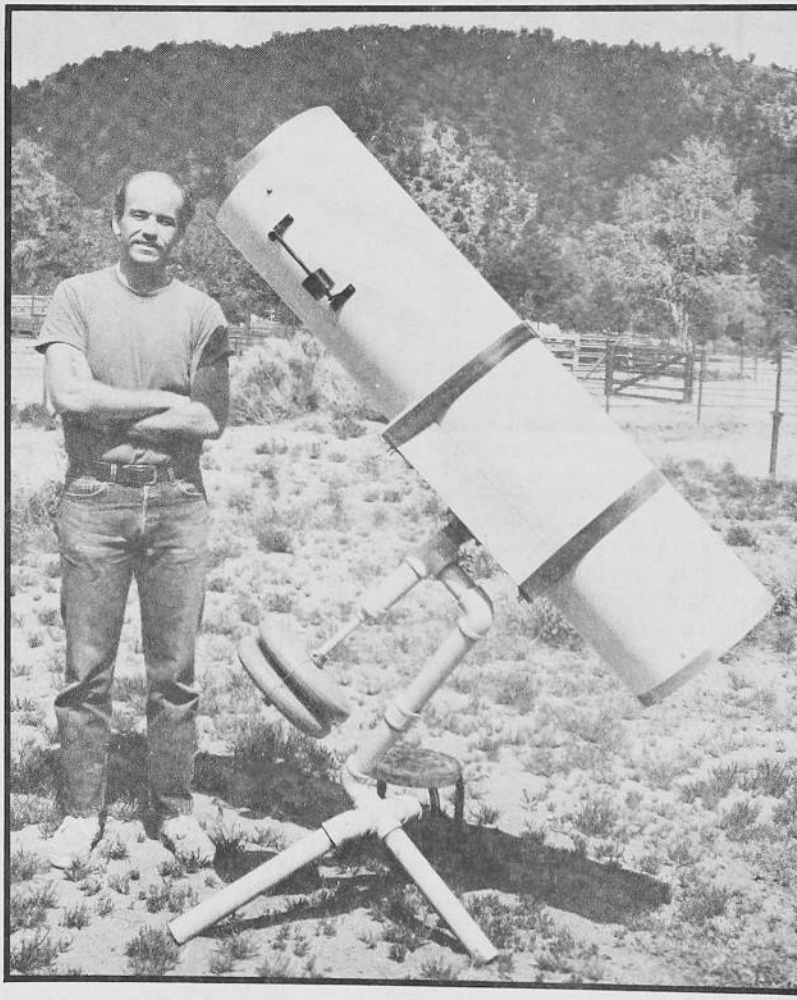
Turning to the main path out of the telescope field, I stumbled upon Bob Pfaff of Torrence, California with his 17.5″ open tube Newtonian. It used light-shielding, but allowed air to flow by using a perforated metal-type screening for the shielding. The right ascension drive was sensibly a lazy Susan driven with a disk by friction on the inside of the bearing and combination double curved bolt drive. The spider support was unusual in that the vanes were at right angles to each other, but only three were used. However, on star images one would still see four spikes! The edge support was a tube with mercury that moved with the telescope and gave enough contact so that no stress was visible in the thin blank. The cell was an 18-point flotation design and both worked well.

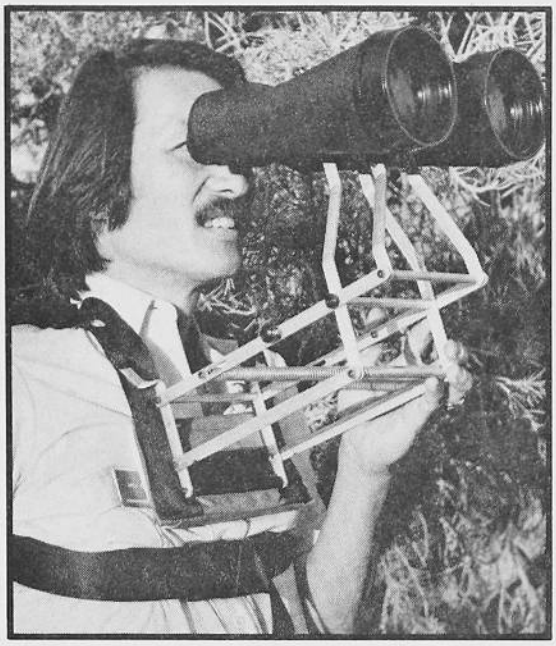
The next instrument was a grand surprise: a three-mirror Schiefspiegler of the Kutter design by Gerry Logan of Lakewood, California. The workman-

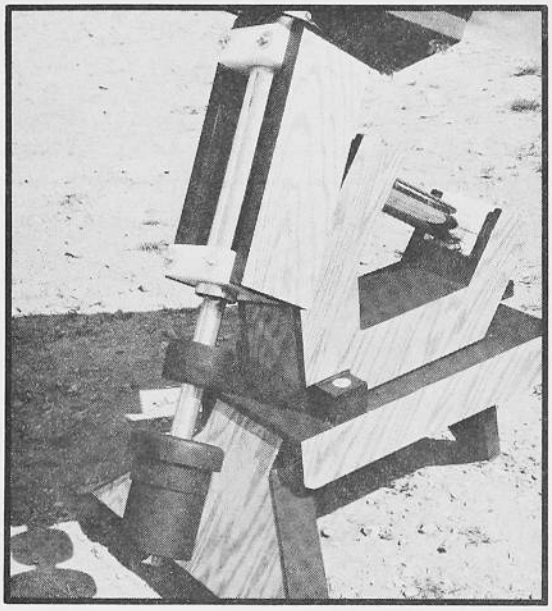


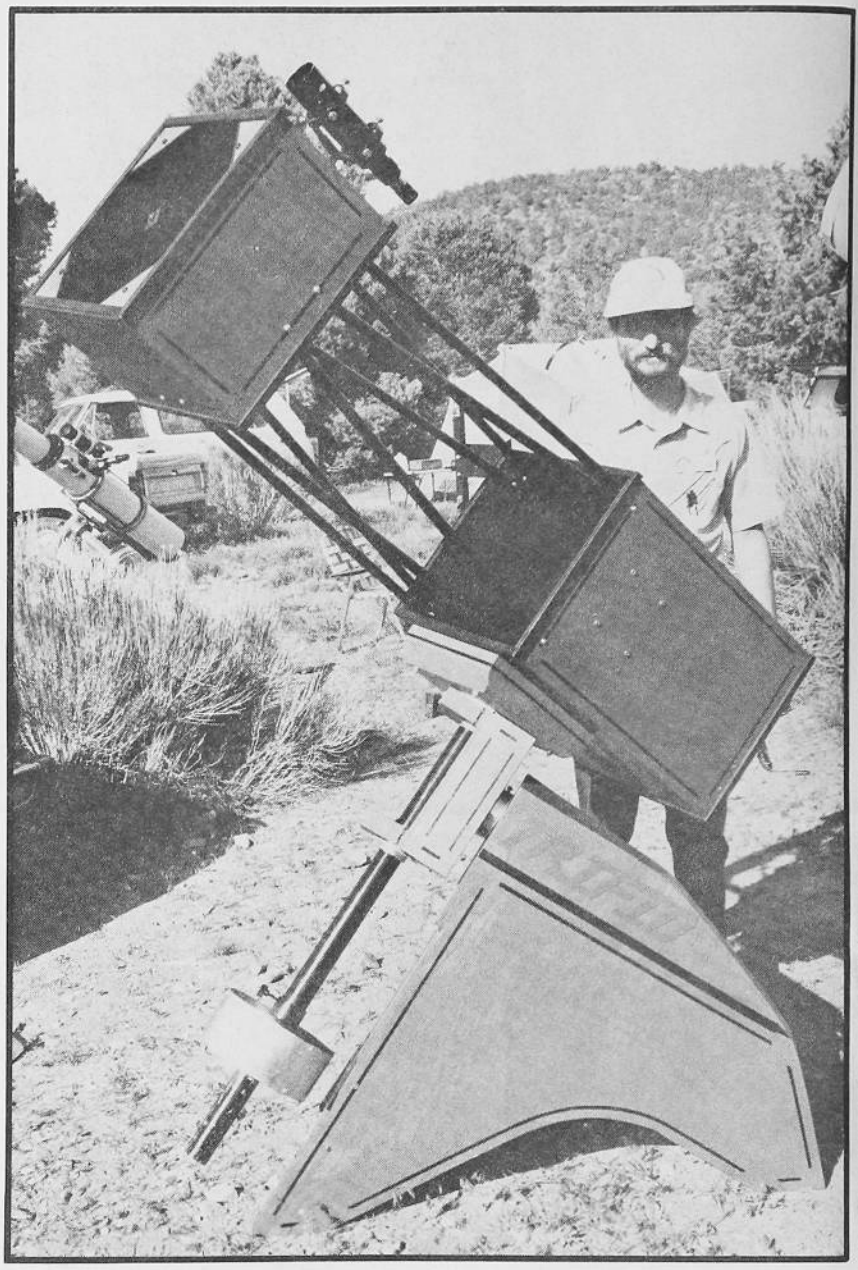












ship on the tube was outstanding and the drive was chain-driven, similar to the ones he uses on his 11″ Maksutov. The fork was fiberglass, but the rest was wood with some aluminum parts. Like the one in St. Louis made by Al Woods (described in TM#16), its performance that evening was only limited by seeing conditions.

Another fine display of a new commercial mounting was from Steven Eubanks of Anaheim, California, owner of Advanced Telescope Systems. He had also done his homework and his design used the principles of R.W. Porter referred to earlier. It had a polar alignment telescope in the polar axle, a clean setting cycle and drive, and a very steady base.

Tom Mission used the front end of a Volkswagen as a trailer to transport his telescope from Bloomington, California to the meetings. The main instrument was a 12.5″ Cassegrainian of f/15 with an 8″ Newtonian f/4 or Cassegrainian f/20 guide telescope. The polar axle had 12″ roller bearings with a 14″ Byers gear drive and 14″ setting circles.

I wandered down the path to see the instruments near the pond west of the lecture hall. Most were commercial, but I did find Peter Fokos of El Torro, California, who had mounted his 12.5″ commercial tube assembly on an equatorial mounting he had made of pipe fittings. The threads were lapped in with fine abrasives to increase the smoothness of motion.

I couldn't find anyone else around the telescopes down in the outback, so I returned to the telescope field. I immediately came upon Wilber Wong of Long Beach, California, whose ingenious kinetic large binocular mounting was to earn him an award. The amazing part of this device is that Mr. Wong bought his 80mm binoculars and immediately discovered that he couldn't operate them efficiently by hand, so he designed a mounting which swings effortlessly (due to the parallel beam construction and careful counterbalancing) through an arc ranging from facing the ground and out of the way when not is use to horizontal and eye level when needed. No matter where one looks, horizon to zenith, the binocular eyepieces swing in an arc that corresponds to the observer's eye location. He has a patent pending on

this design, but told me that any amateurs wishing to use the idea for their own personal application were free to do so. The axes on the new Image Point mount were smooth and steady and easily carried at 14.5 telescope. The mount was named Elysium for the famous Martian feature seen in amateur telescopes.

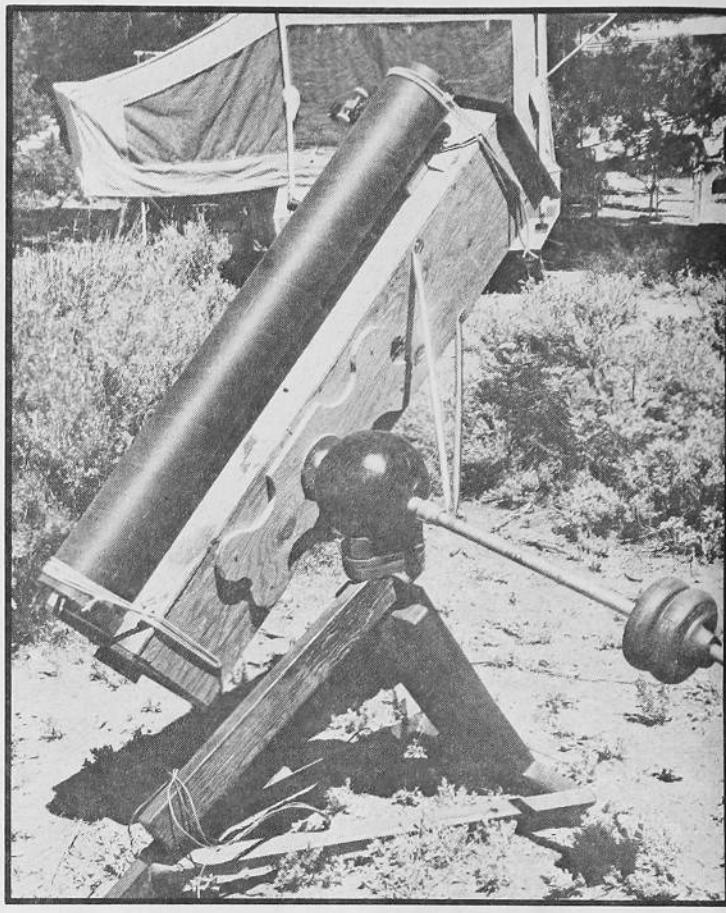
Chris Schur exhibited his award-winning Trifid telescope, named after his favorite object. He made the full thickness 12.5" mirror, and for increased light grasp, all the optics are silvered so the mirror is equivalent to a 14.5" in light grasp. The total cost to build it, less optics, was about $30, since all the wooden parts were scrap pieces. He has achieved his goal of building a high resolution telescope with low thermal problems using wood and the spider vanes of fiberglass. The bearings are Teflon and the counterweight is made of wooden disks filled with 35 pounds of lead shot. The mirror is silicon mounted to the wooden cell, and an epoxy coating makes the rubber stick to the wood. The rubber must have a thickness of at least 1/8", as anything thinner warps the optics. To obtain proper thickness, Chris put spacer blocks around the edge of the cell and then put the mirror on the silicon rubber, where it settled down until stopped by the spacers. After the rubber had set, the blocks were removed. The construction of the cell is as open as possible for ventilation of the mirror, and the cell has push-pull bolts for the alignment so once it's set, it never goes out of adjustment (see TM#6). The telescope stabilizes in 30 minutes. It is painted red for the color of the Trifid Nebula and dark line patterns on the mount represent the dark lanes of the Trifid.

I found Tom Fangrow of Corona, California at the center of the observing field with the most ingenious and simple drive system for equatorial platforms I have ever seen. His "Hiss Drive," as he calls it, works on the principle of an air cushion in the form of a tire inner tube, which controls the escape of air and lowers his table or platform to track celestial objects. He discovered that air captured in the center of the tube caused instability and bounce when the telescope was touched. He found one solution was to place a thick piece of string under one edge of the tube which allowed this air to escape slowly. He displayed a second mounting in which he had drilled four holes in the center of the surface supporting the tube, which also helped to eliminate the instability problem. Tom was given the Warren Estes Award for the best use of simple materials, such as a piano hinge, some plastic tubing, a tire valve, a needle valve from the air feed for aquariums, and some wood. The "Hiss Drive" and Mr. Wong's binocular holder were without a doubt the two most outstanding amateur exhibits of the meeting.

On the road to the outback, I found Dave Kenyon of Loomis, California, who had a square wooden tube on his 17.5" Newtonian. The tube walls were made of mahogany door skin 1/8" plywood and weighed only 22 pounds, half that of a Sonotube of the same size. The material was also warped to surround and protect the drive. The mirror cell contained a 90% flotation system and consisted of 7/8" plywood surfaced flat, with holes drilled in it for ventilation and mirror cooling. The wood had a layer of silicon rubber covered with a cork sheet, with the mirror placed on top of the cork. The assembly seeks its own level; since the cork has a high static coefficient of friction, the mirror does not slide easily. Edge clips keep the mirror centered and prevent it from falling forward.

For locating objects in the sky, Dave Housekeeper of Lancaster, California had his telescope mounted on a bowling ball and for tracking he had a polar axis articulated by two common door hinges driven by a tangent arm drive. A motorized strap hinge at the south foot of the assembly tilts the unit for declination control in photography.

Susanne Mau of Riverside, California displayed a single-arm fork equatorial mounting built by her boyfriend. It carried the 10" f/4.5 handily and



eventually will be adapted for photography. It appears that many Dobsonian owners are seeking regular equatorial tracking for their instruments and abandoning the Dobsonian mount.

There were a good number of refractors displayed. Towering above the field was the 8″ f/15 of John Pons. It was operating stopped down to 4.5″ f/30, for use with a .42 Angstrom bandpass hydrogen alpha filter for solar viewing.

Richard Andreassen had two mountings on display. The largest carried an 8″ f/5, a 4″ f/8 and a C90 and is used for deep-sky photography. Although a complicated-looking system of gears adorned this equipment, his examples of deep-sky work were so outstanding that he received an award.

Nearby was a fine-looking 4.25″ f/26 Kutter Schiefspiegler, but the entire time it sat unattended, without an eyepiece, so no one ever got a chance to look through the instrument. It was a shame, since the performance of this simple telescope is, for its size, an eye-opener. A similar one that I built in 1962 is still my favorite lunar and planetary scope.

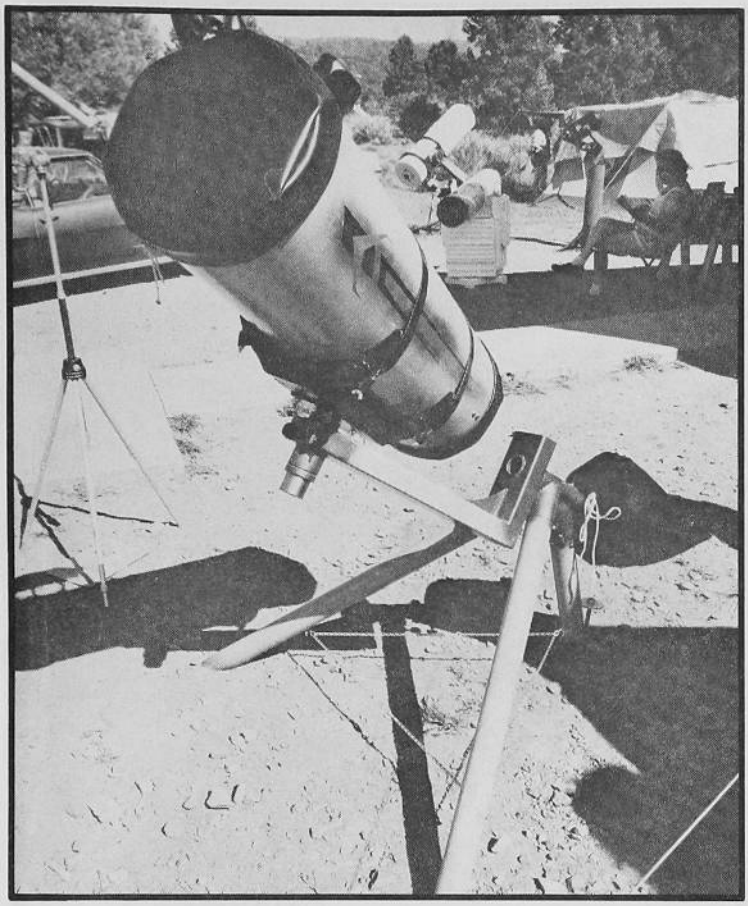
The largest instrument was a 20″ Ritchey-Chretien f/8 Cassegrainian made by Kim Gordon, who I never found to ask more about it. One of the problems at Riverside is that people dump their equipment and go off, and no one can question them about any special properties their instruments might have. It would be nice if two hours could be set aside when all of the delegates with instruments would have someone present to answer questions so one could circulate and get information.

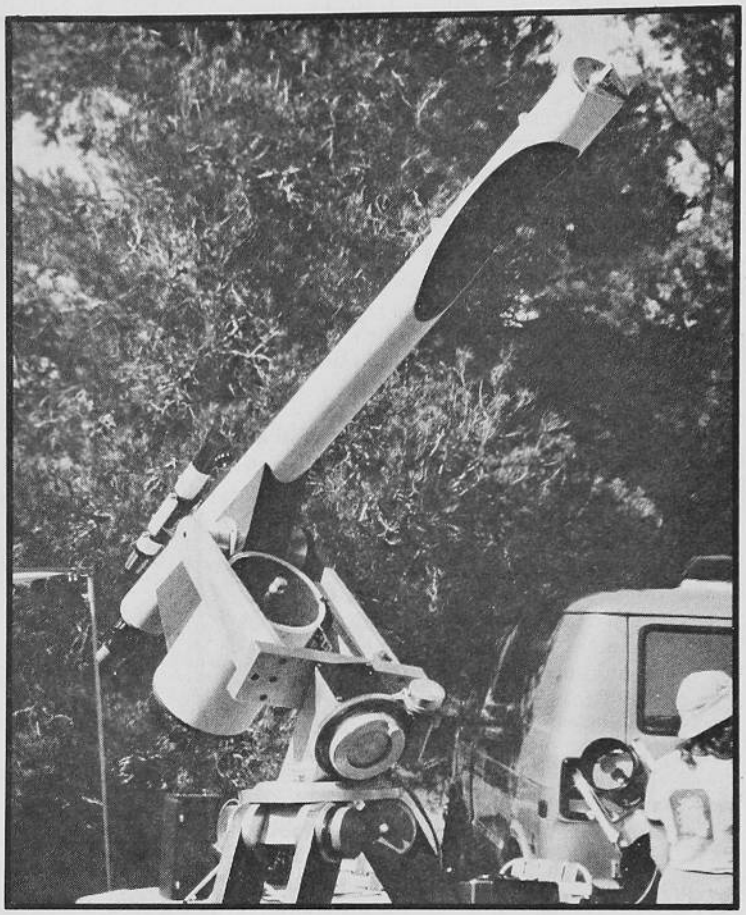
Mike Hill of Claremont, California made his simple all-wooden open tube Dobsonian. He ground his own 17.5″ mirror to 80″ focus and the mount is 1x4 laminated redwood which damps out quickly after being moved or touched. Although set up late in the meetings, this scope attracted considerable attention because of its unusual appearance and workmanship.

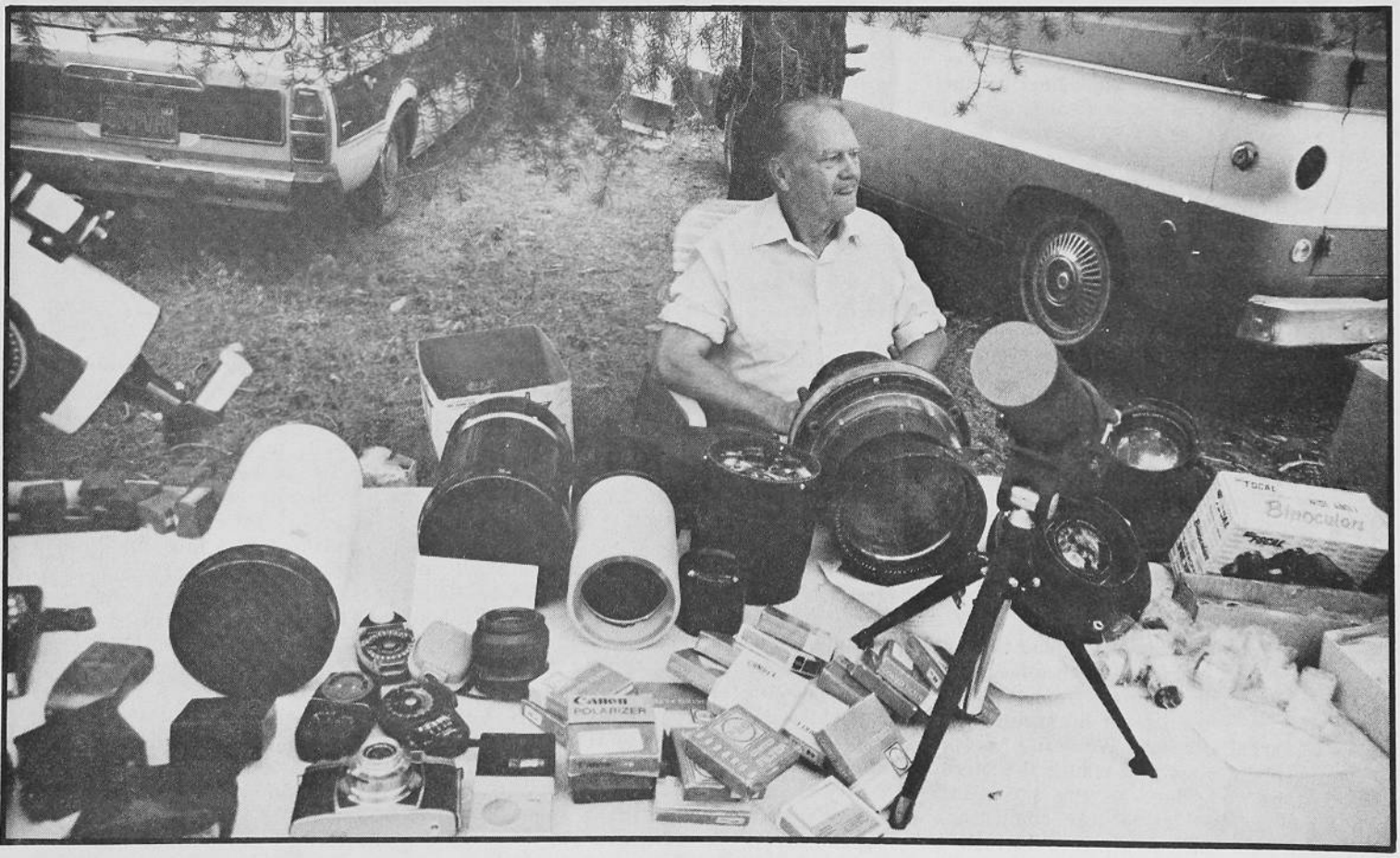
One of the most pleasant things about these meetings is getting together with old friends. Late Friday afternoon, I turned around and was surprised to find Dick Buchroeder. He had indicated in letters that he probably wouldn't be able to attend, but a last minute change in plans brought him to Camp Oakes. Dick is well known to telescope makers for his excellent designs and articles published in astronomical journals. We had a ball looking at the various instruments together, especially the three-mirror Kutter Schiefspiegler. He became engaged in some serious conversations about optical design and it was enlightening for me to stand there and just take it all in.

Friday evening I had the privilege of presenting my "Time Machine" talk so everyone could go with me down memory lane of past giants. Being an "old" T.N. (I finished my first telescope 50 years ago this year), I started attending Stellafane meetings back in 1937 and shared my photos of those olden times. It was an honor to have met Porter, Ingalls, Everest, Dr. Paul, and many others and now be able to display their pictures and talk about them. My talk is strictly for telescope makers and has always been well received. It's great to have so many people come up afterward and say how much they enjoyed meeting the old masters. One amateur told me that my description of how the members of the Boston Amateur Telescope Makers, back in the 1950s, had mounted their Newtonians had inspired him to duplicate the idea for his next telescope. Yes, it is fun to be a "historian" of past events even if I have to be "old" to do so!

Saturday morning Ashley McDermott officially opened the meetings, followed by a special presentation by a well-known amateur, writer, and popularizer of astronomy, Ben Mayer. Ben, like





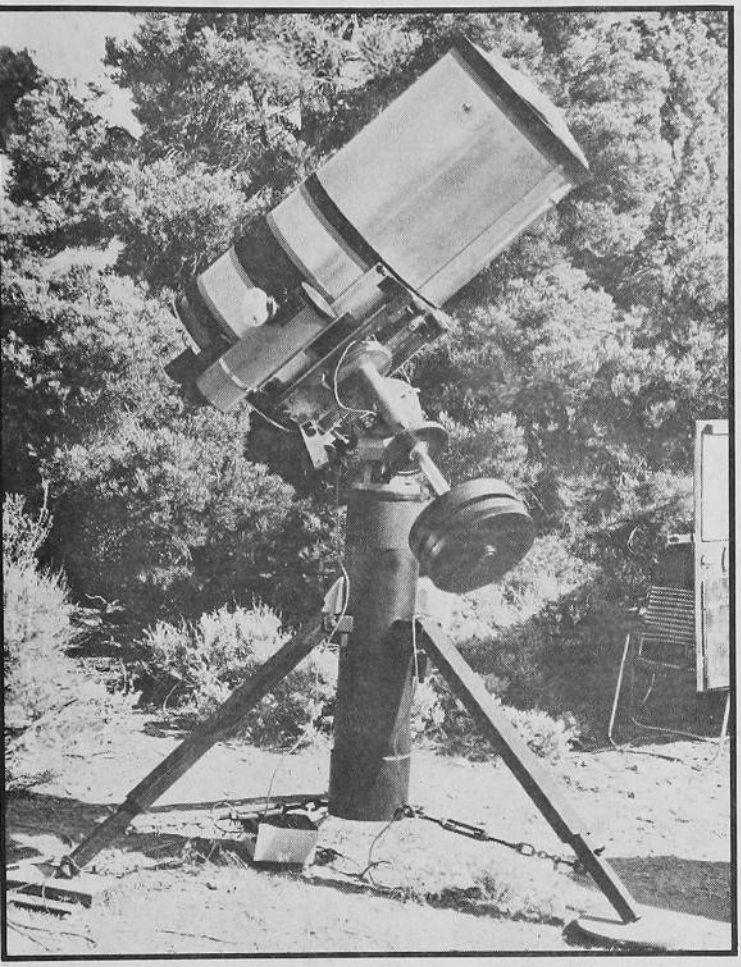

Canon
POLARIZER
Binoculars

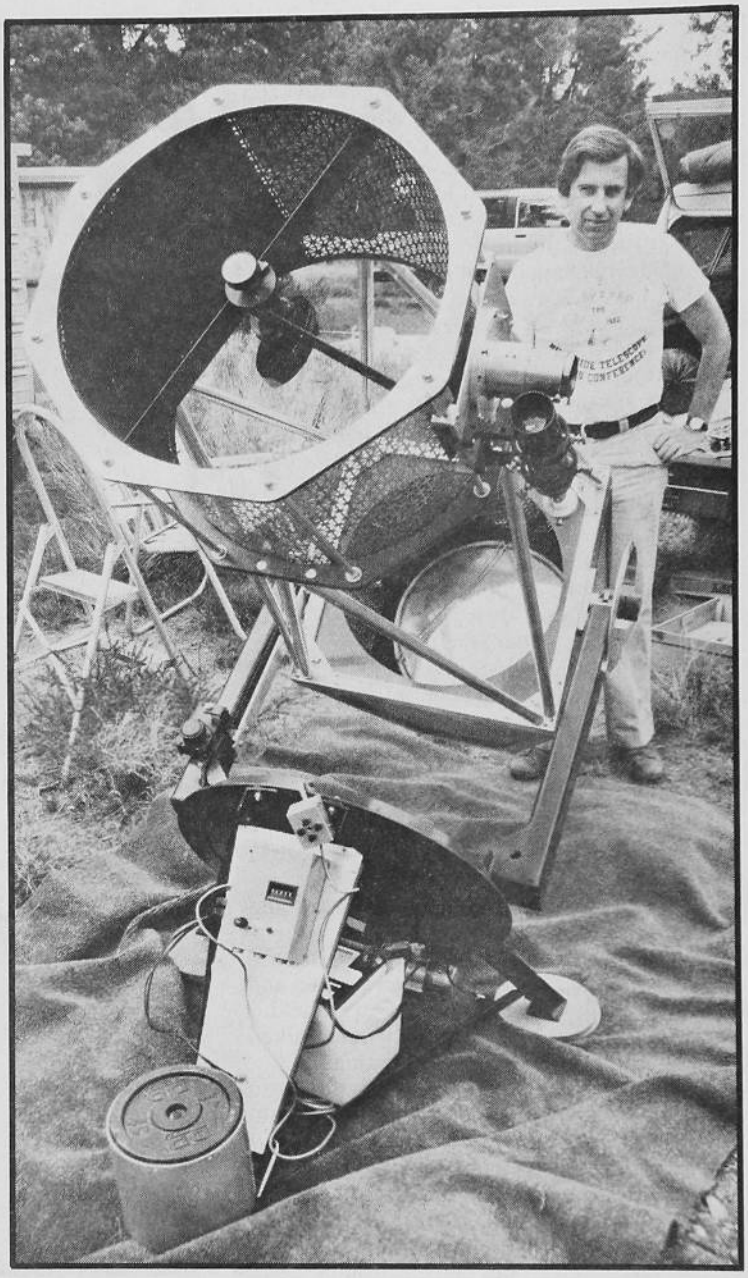
many of us, is greatly disturbed by the possible closing of Mt. Wilson Observatory and he presented his plans to try to get this famous institution a stay of execution. I had heard of his project, and although he has the best of intentions, his actions could jeopardize other plans already in the works to solve this problem. His idea is to try to convince those in charge that if they televise the image of Halley's Comet as seen from the Observatory, the importance of the observatory would be realized and perhaps it might be saved. In my estimation, nothing is more unsuitable than using a 100" telescope to image the comet, and I believe that any "gadget" approach will not illustrate the intended purpose of the telescope. Mt. Wilson might be saved if it were declared a national landmark, and it certainly deserves this distinction for the numerous discoveries that have been made over its lifetime with the Hooker telescope as well as other equipment there.

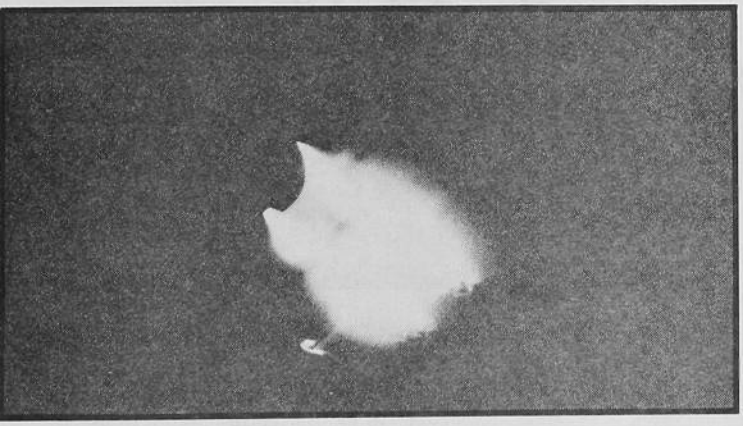
Although the swap meet was supposed to start Saturday at 1 p.m., many of us were set up much earlier. Many of the optical parts I had accumulated over the years were just sitting in my basement and would never be used, so I had packed boxes of them in my wagon and pulled them out for display, but few sold. I guess they were either too special or people didn't have the money for them.

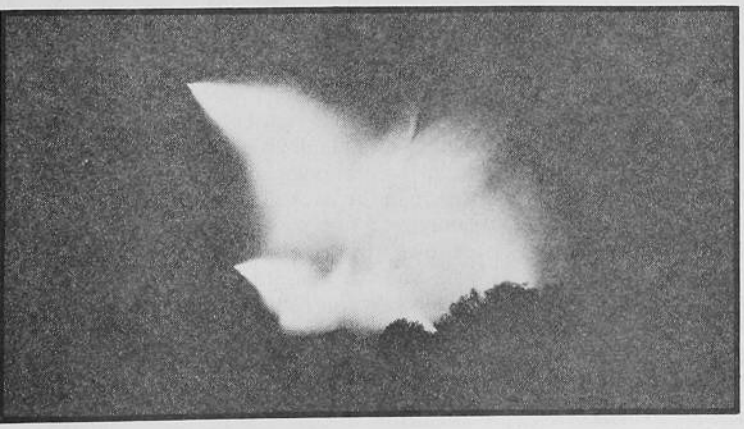
The meeting hall overflowed Saturday evening as the crowd waited for the announcement of the door prizes, making it necessary to pass word outside if no one inside had a winning number. Cliff Holmes set the spirit of good fun by yodeling a few notes. After half the prizes were gone — the rest being saved for Sunday evening — the crowd thinned. Some stayed for a talk by Steven J. Edberg on Comet Halley; others returned to their telescopes to prepare them for the night's observing. Because of the stony paths, I decided to take advantage of the remaining light and return to the telescope field. Dick Buchroeder and I went first to the three-mirror Schiefspiegler which was turned on Saturn. The image was excellent, but seriously limited by seeing conditions. As usual at Camp Oakes, air moving over the surrounding mountain peaks created eddies which caused turbulence in the viewing field.

Dick is a "lens person" and showed interest in looking through some of the refractors on the grounds (I introduced him to reflectors but his true love is apparently lenses). We didn't try any deep-sky viewing because the bright Moon rode high in the sky. After looking through a fine commercial refractor, Dick returned to the lecture hall to meet a friend. Around 8:30 p.m., as I stood talking to one of the delegates, a great cry arose from the telescope field and I immediately looked skyward and rotated my scope, expecting to see a brilliant meteor with its train. I didn't see anything, but I still heard cries. Trees blotted out my view of the western portion of the sky, so I ran to the large field and looked west. In the past I have seen bright comets, a −5 magnitude fireball that spanned over 120° of the sky, an aurora in Maine, and the launch of Mariner 9 to Mars, but now I stood in amazement looking into the western sky. There had been a double night launch of rockets from a submarine off the coast. Close to the horizon were two twisting green and blue vapor trails radiating from the launch site. The rockets sparkled as they reached altitudes where the Sun was still shining and the exhaust from the two rockets formed a huge white cloud. I heard one amateur remark, "There goes deep-sky observing." But I thought, if true, it was well worth it! The rockets skirted the edge of the white cloud, one about 10 to 15° above the horizon; the other close to 45° above it. As I watched, Wilber Wong thundered past me. When he returned, I saw that he had strapped his special binocular support on his chest and had picked up the rocket with his 80mm glasses. His device worked beautifully









as he tracked the rockets across the sky. All of us cheered as the first stage of separation occurred. Apparently the upper air currents were strong, because Wilber said that the exhaust trail was twisting and turning. He said that at one point it looked like the rocket was coming straight at him. After several minutes, he lost track of the rocket in the binoculars, but another person with a 17.5" Newtonian had picked up the rocket's tail and tracked it until the rocket passed behind the surrounding mountains. I watched the lower vapor trails above the launch site for at least 20 minutes, but the huge white cloud soon became faint and diffuse in the moonlight.

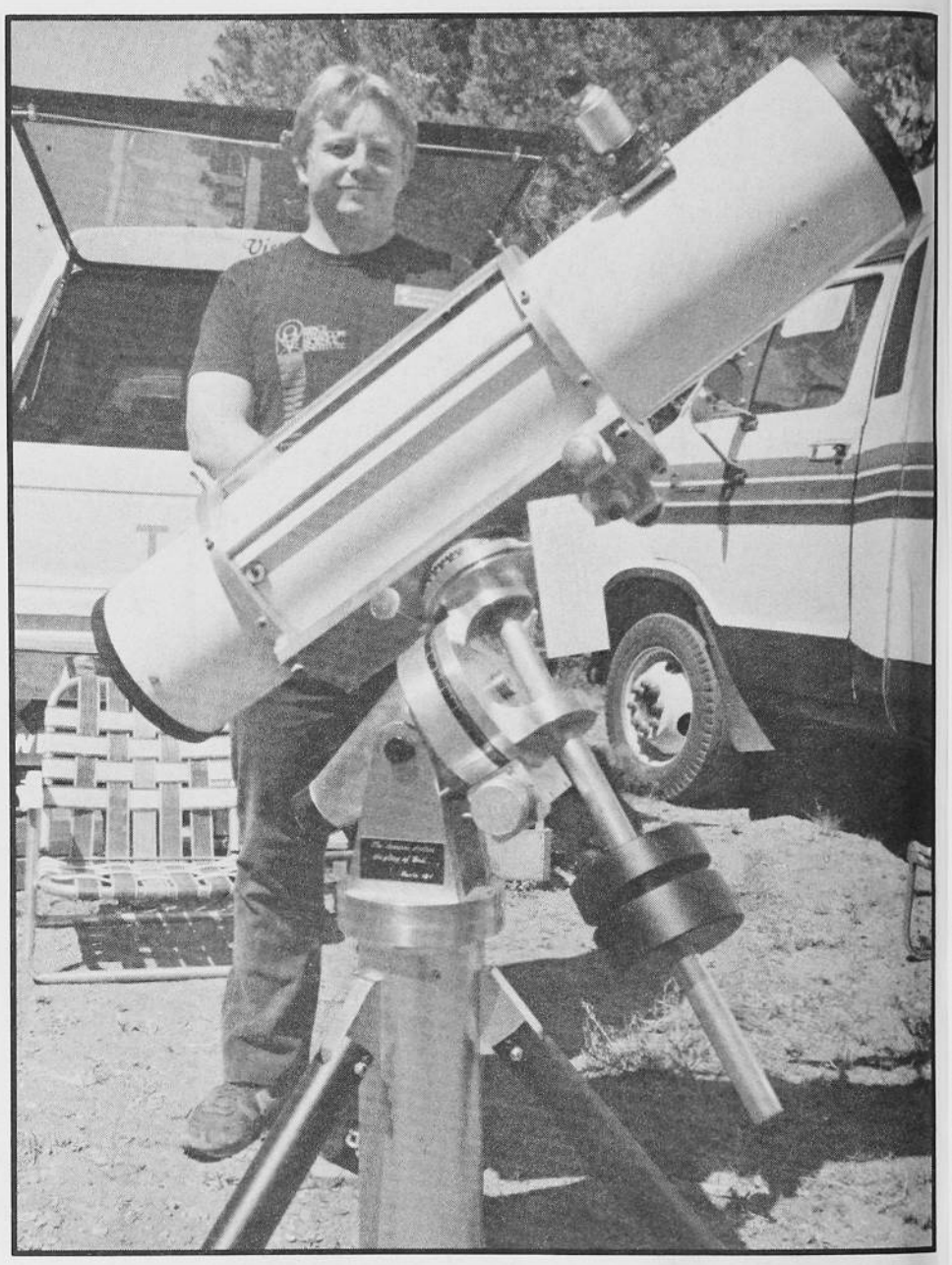
The next day, opinions were mixed on what we had seen, since information about the cargo of launches isn't always released. Some thought they were missle tests that would splash down near a target area in the Pacific Ocean. Someone mentioned that they had heard that a navigation satellite was due to go up soon and perhaps that was the launch we saw. We will never know for sure, but it was one of the most exciting sights I have ever witnessed.

With all the excitement over, I suddenly realized I was cold — my light jacket should have been my leather one, so I returned to the bunkhouse and turned in early.

On the next day, Sunday, nothing was scheduled until 9:30, when a comet and astrophoto workshop was to be held. I went into Big Bear City and talked optics with Dick over breakfast.

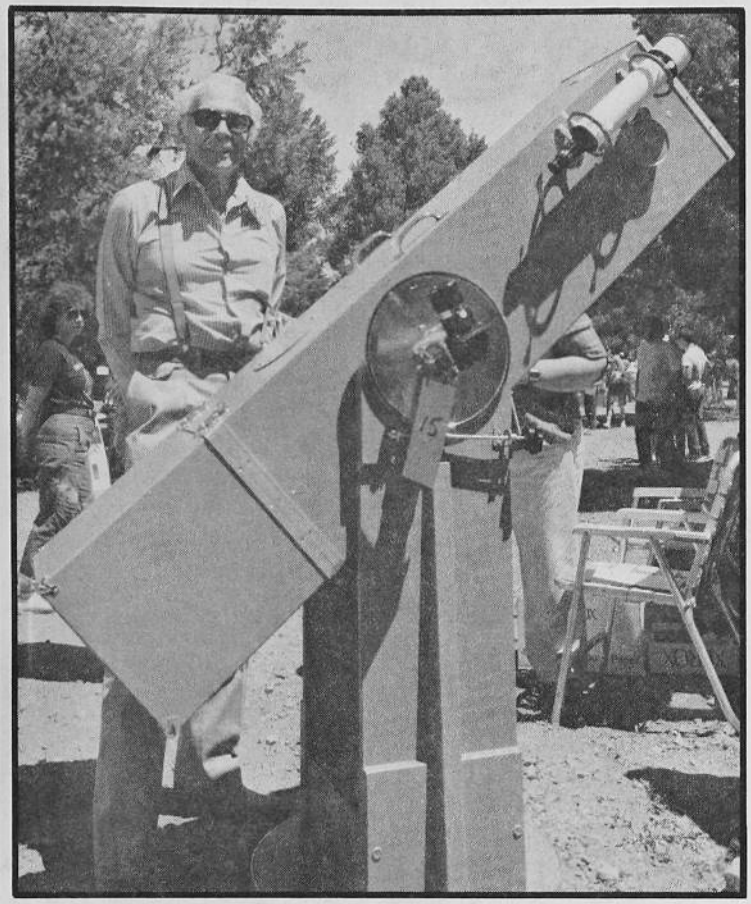
After breakfast, Dick started back to Tucson and I wandered the fields again looking for instruments and information. On the trails I came across Dave Kenyon, who took one look at me and in sympathy offered me a chair and a cold beer. We sat comfortably and talked telescopes and electronics. Dave has developed a sophisticated computer-controlled system for telescopes, and he asked me if I thought it was suitable for the average amateur. I told him that sharing his ideas would encourage others to examine them and perhaps even simplify his original, so there was merit in publishing something good, even if it was technical.

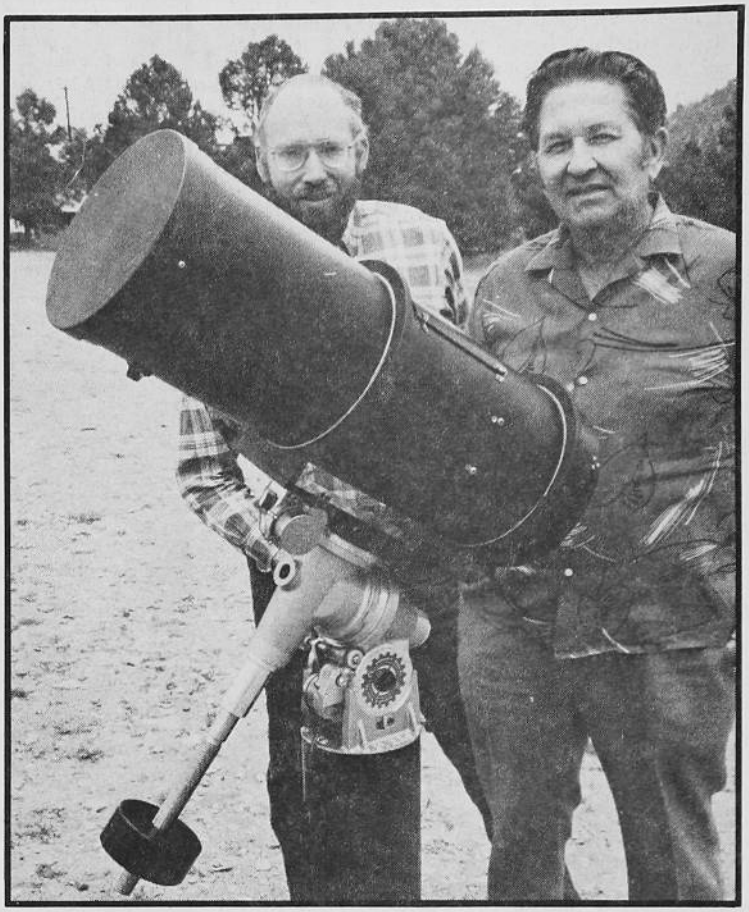
At 3:00 p.m. I returned to the bunkhouse, put on my special Saturn tie, and prepared for my presentation on "New and Exciting Optical Designs." Heinz Klee, from the National Research Labs in Pretoria, South Africa, had sent me his material over the years, and since Heinz couldn't be in the U.S. until early June, I was presenting his material. He later attended my optical design workshop in Tucson at ALCON 85. I reported on a three element Barlow yielding 3x, and one that is variable from 1.5x to 30x that was spherical and color corrected but not for coma.

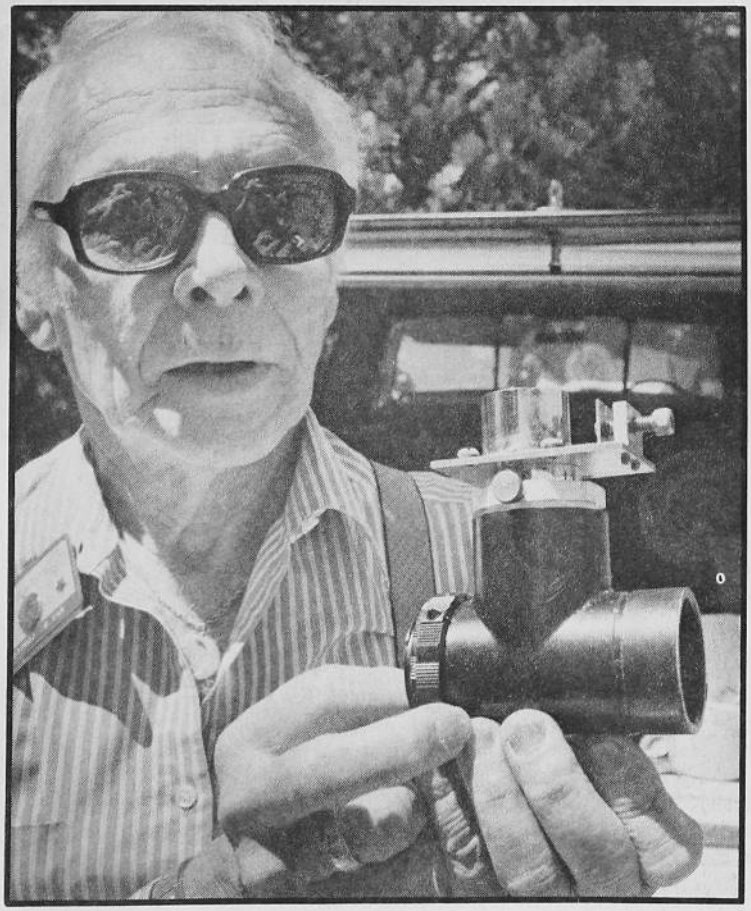


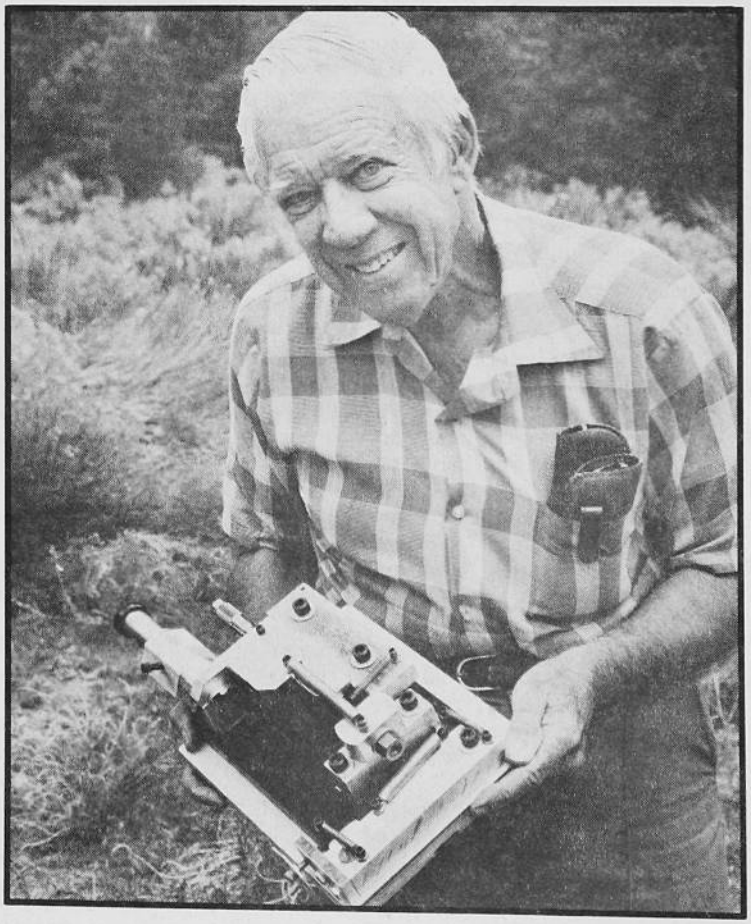
I managed to hear parts of several talks: Richard Bean's on an amateur observatory, R.C. Victor's on Mars, and Steve Edberg's on folded refractors and apodizing screens. I found that this meeting was too huge for a single person to adequately cover all the activities. In the future I hope that if other staff members cannot attend, they will elect some knowledgeable amateur to assist. It is not possible to both attend the paper sessions and prowl the fields looking for telescopes and people to photograph and interview. I was disturbed by this because I felt that if people came to my presentation, I owed it to them to go to theirs, but I did the best I could and I hope those who gave papers will understand if I can't give them all a review. I'm sure the talks I missed were as interesting as the ones I heard.

On Sunday afternoon, I searched for Mike Simmons, who I had met at the Texas Star Party in 1980. Mike has written a fine computer program for designing optics and I found him and his system — a professional AT&T machine — set up in the back of the lecture hall. He only works up new designs and then tries to sell them to interested parties. I was able to examine some of the enlargements from his 12" f/5 Astromak and see the computer readout of the design from his printer, both of which were very impressive. He had several others that appeared to be useful for the









amateur but he hasn't been able to sell them to the people who would use them.

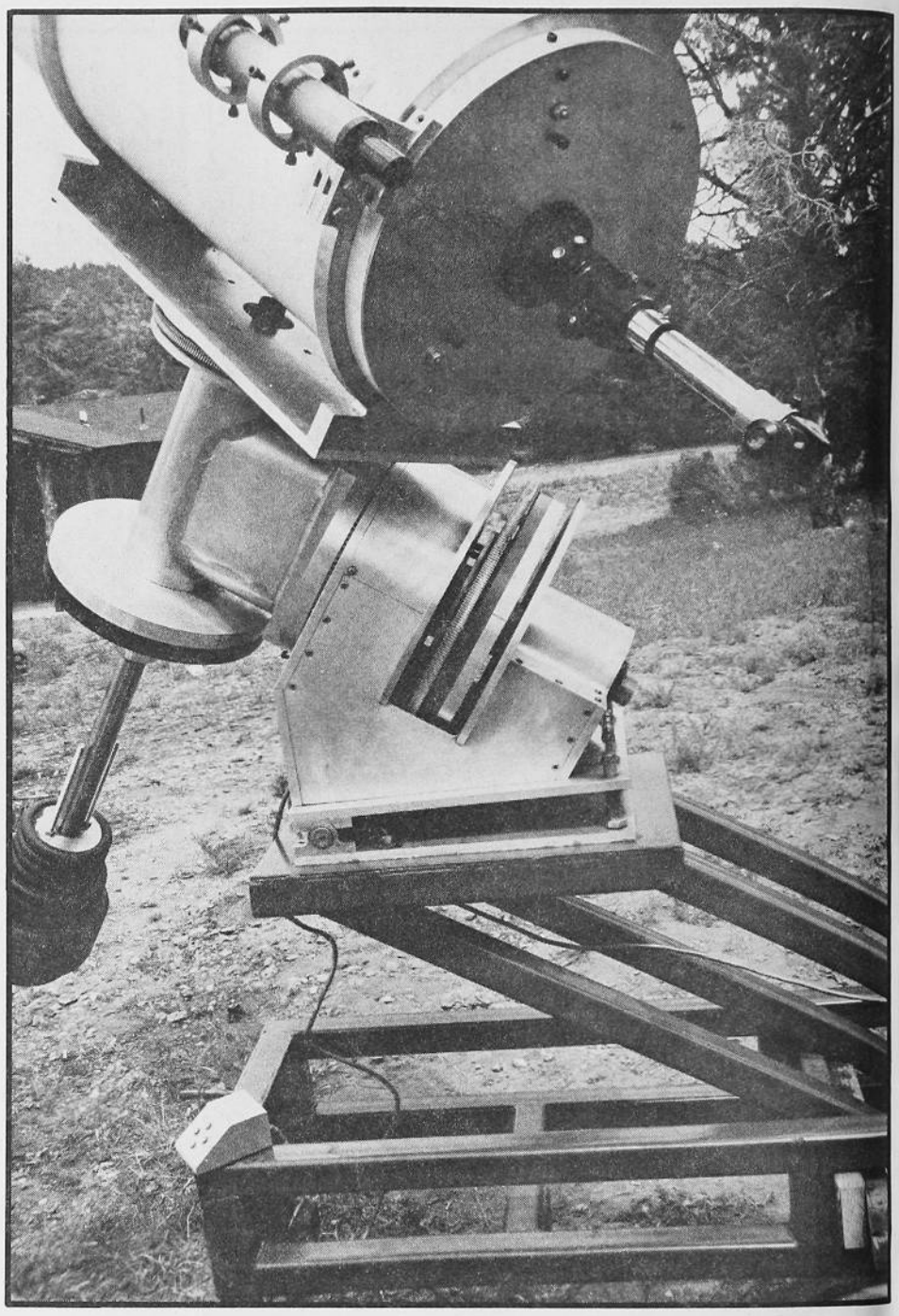
Mike and I went outside and discussed his project involving a computer controlled telescope for a 20" Simak that can find celestial objects by size, magnitude, and position. The project uses an 8052 microprocessor that has a 32K assembly language program and contains the entire NGC catalog, including right ascension, declination, size, magnitude, object type, and a quality measure for every object. His eprom chip will also include the hundred brightest stars and an additional 140 objects he has yet to decide upon. He has updated the NGC catalog by including sizes and giving magnitudes to 1/10.

I returned early for the dinner line but was shanghaied by Tom Mathis and Paul Zurakowskie to try out their optical measurement and design program on their Macintosh computer. They have developed an interesting program with graphics and menu selections that made operation easy. It was the first time I ever worked with that machine and its mouse control and I became so involved that I almost missed dinner.

I noticed a disturbing trend at the meetings this year which I hope will be temporary. There was a lack of very many true telescope nuts (TN's). Of all the instruments I saw, I would estimate that less than 3% had optics made by the amateur. We are becoming a group of telescope owners who buy the optics and assemble all kinds of mountings. I have heard some people say, "Why make a mirror when I can buy one for less money"? What a sad statement! Where is the thrill of accomplishment that comes from fabricating precision optics with your own hands? Where is the learning experience of how optics operate, and the testing knowledge of how to evaluate their performance? We who are TN's should encourage more people to fabricate their own mirrors, lest our hobby lose touch with its greatest accomplishments of the past.

A huge crowd came out after dinner for the awards and door prizes. I was pleased to hear that Arthur S. Leonard won the Clifford W. Holmes Award. Art is a shy, retiring person and wasn't even in the room; he had to be brought in from the telescope field to receive his well-deserved recognition.

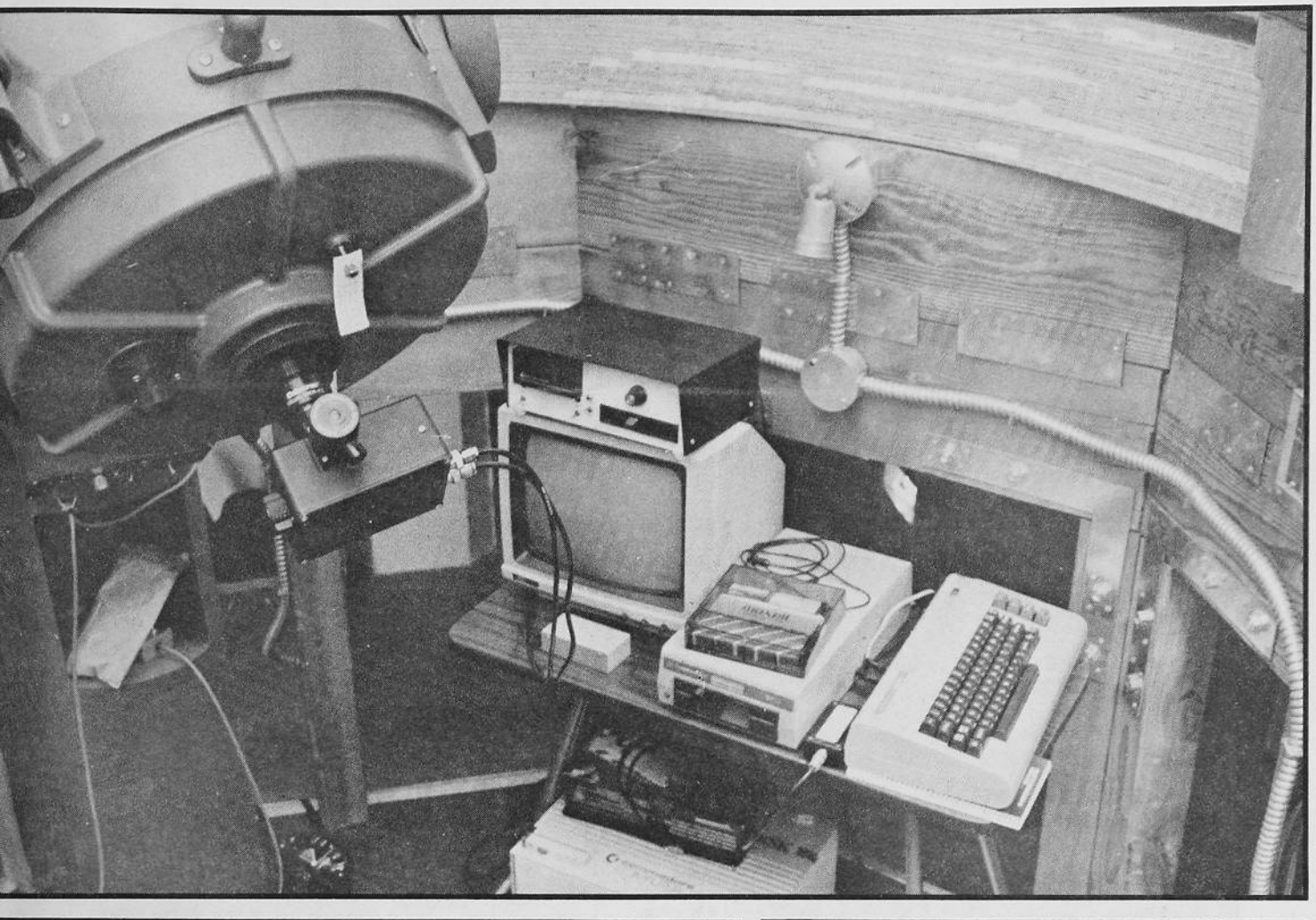
There was a special bit of tomfoolery that had the crowd in stitches. It involved George Ellis of Texas Star Party fame, Dave Levy and some others, and involved the use of a hammer, a tall black pointed hat, a bit of wood, and a long cardboard tube. The sacrifice of this so-called "telescope" was to assure perfect seeing and optics for the coming year, but just as the hammer was about to descend, Dave Levy saved the day and rescued it. The crowd loved it! These amateurs are a great group of nuts and fun-loving people.

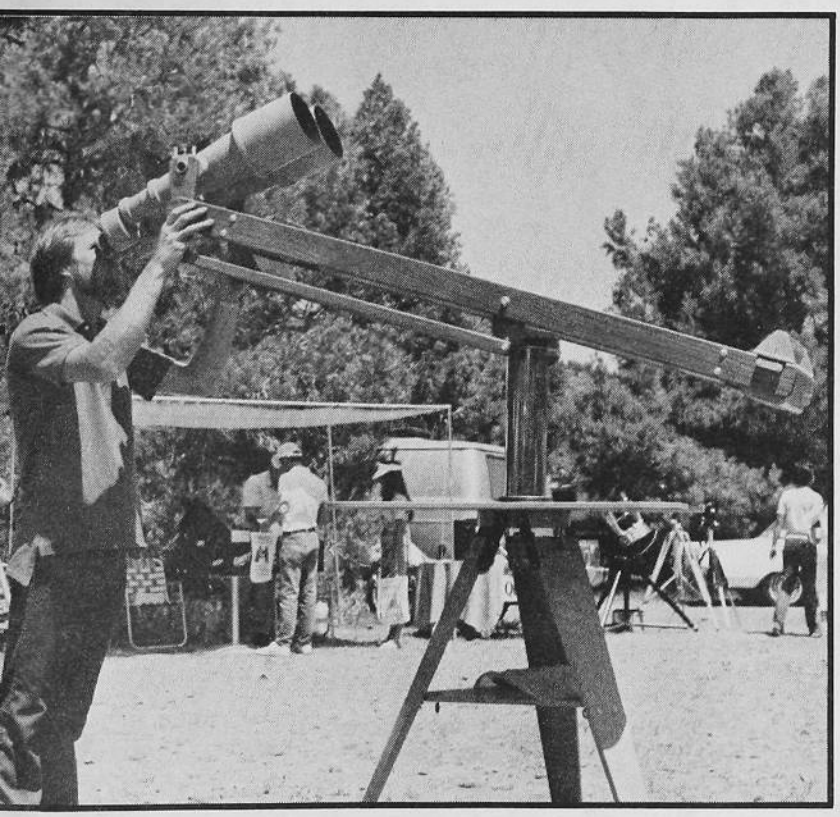


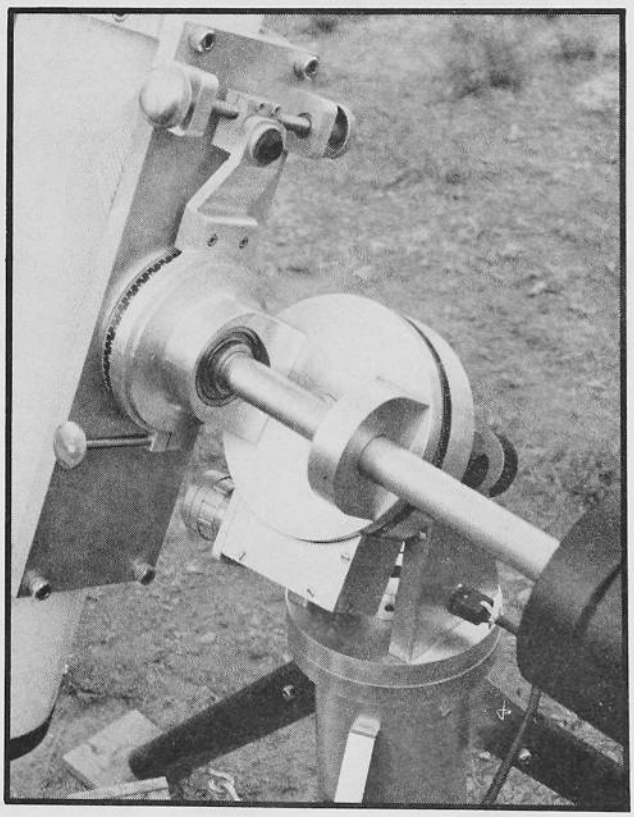
That evening I spent some time looking through some of the excellent instruments on the telescope field. By 10:00 p.m., however, I turned in because I planned to get up early and head back to O'Fallon. There was film to develop and material to be written when I got back, and then it was off again for the Tucson meetings on June 10th.

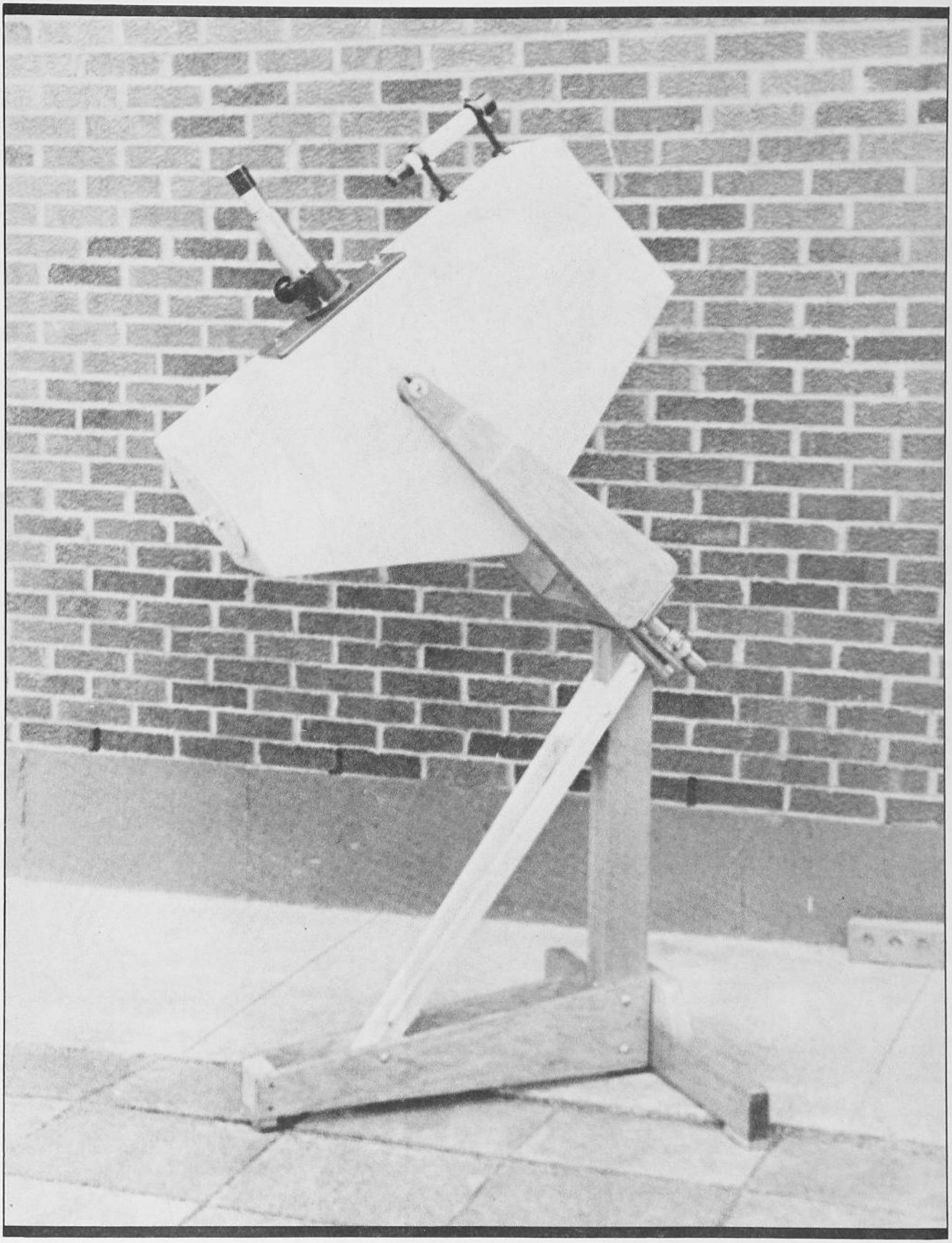
At 5 a.m. on Monday I loaded my car and started back to Barstow for breakfast. From there it was a long haul — 759 miles — to Albuquerque. The next day I drove to Great Bend, Kansas, and Wednesday, after logging a final 459 miles, I was home in O'Fallon. I walked in and asked the wife if she wanted to go dancing, and she led me over to the couch where I immediately collapsed. It was a great meeting, the largest crowd ever — 1373 — with 44 telescopes entered for award consideration. I know that next year will be just as exciting.

Robert E. Cox









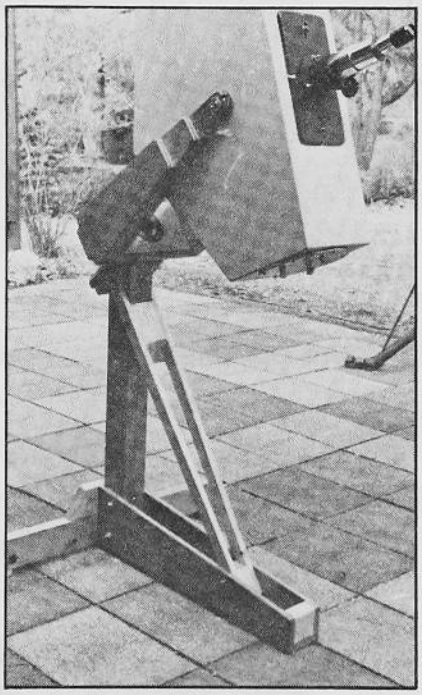
WOODEN Fork Mounting

Lightness, economy, ease of working and finishing make wood an attractive material for an amateur's telescope mounting and stand. Several years ago, I built a light, portable, fork-type equatorial mounting for my three telescopes: a boxy Kutter Tri-Schiefspiegler TCT (see TM#16), a square-tube "Cass," and a Newtonian tube cradled in a box. The only metal parts in this mount are the shaft and bearings — and the bolts to allow easy disassembly. In addition, it has a large enough base to balance the overhanging weight of a 25-pound telescope without a counterweight — for extra stability, a brace may be added to the post. Fixing the block for the bearings directly onto the top of the post further steadies the action. Its total weight is 33 lbs.

Fork Design & Patterns

My drawing should serve as a guide for adaptating this design to your particular scope and viewing positions. Cuts for the stand can be figured directly onto 2 x 4 lumber, but a full-size master layout of the fork should be made to give the exact pattern for each part and work out clearances needed for the telescope case. The patterns are transferred from the master and traced onto the sheet of ¾" plywood. Allow for the width of saw cuts and the most economical use of material. The careful layout on the sheet aids in squaring and in accurately cutting out the parts with a sabre saw. This small power tool is easiest to use when the sheet is clamped across saw horses.

Since it is impractical to drill a large hole for the polar axis through several inches of solid wood in the finished fork, a very careful layout of the position for the hole must be made in each of the base parts. The hole saw or cutter should be carefully selected and used with care. Slightly larger holes are required for the flange. The fit of all the pieces should be tested before assembly.



The flange fits securely into the first base part, but a little extra work on the hole may be necessary if the flange casting is not true with its threads. Steadiness in this type of mounting depends on the polar axle supporting the base of the fork securely, and the cross section of the arms and base resisting torsion and flexure in holding the scope.

Polar Axle

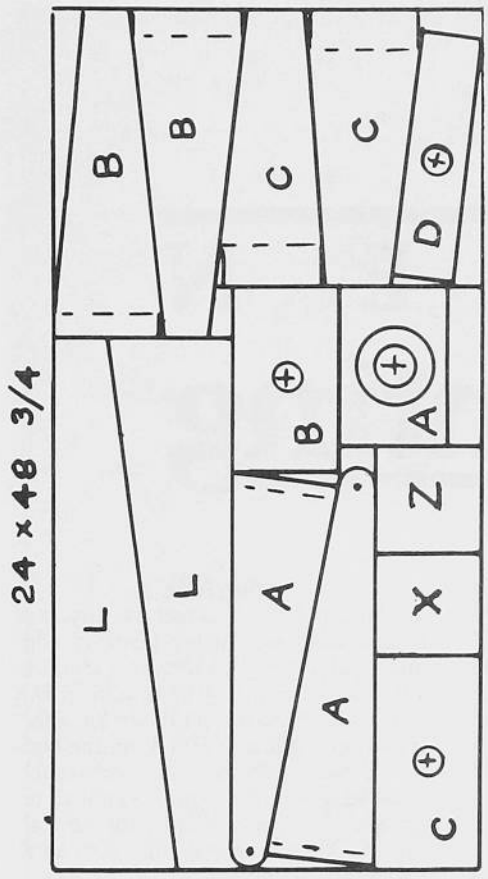
A large polar shaft offers stability, but a solid shaft and heavy bearings add undesirable weight and cost. I chose a hollow shaft of a 12" joint of 1.25" (I.D.) iron water pipe turned down smooth. It had the standard threads on the end for a flange whose base was reasonably squared. For those fortunate enough to have facilities or a friend with a metal turning lathe, turning this shaft and flange will be a snap.

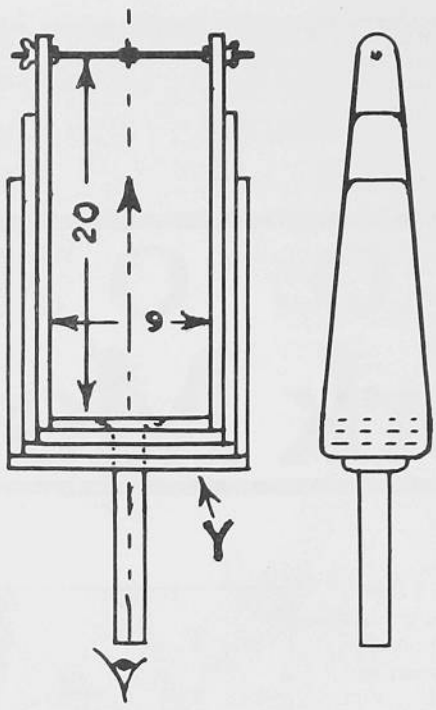
I had to jig up a makeshift lathe. Wooden end plugs were cut with a hole saw and tapped into the ends of the pipe so it didn't wobble on a small shaft between wooden blocks on a work bench. Belting turned on another plug at one end of the pipe. A tool rest on which to steady a marker and the wood blocks with abrasive paper was provided by a wood board paralleling the pipe.

The coarse irregularities on the pipe surface are due to the distortions given the pipe during forming and threading in its manufacture. These were dressed down with a hand file. High spots can be indicated by holding the tip of a marking crayon to just touch the high spots as the pipe spins.

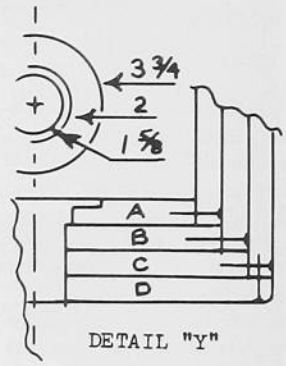
Next, the high spots and areas are ground down by using a quarter-sheet of coarse grade carborundum paper backed by a flat block held against the spinning pipe. Use only enough pressure to hit the high spots and rest part of the block against the tool rest, shifting positions along the length of the pipe. Use the marker frequently and work on the areas it touches.

The vibration gradually reduces. The successive wear of gradually finer abrasives will bring the surface to a





Plan of Fork



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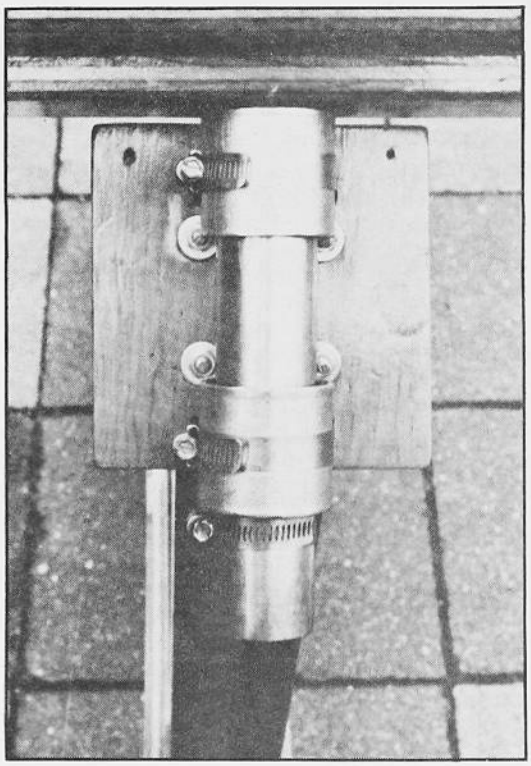
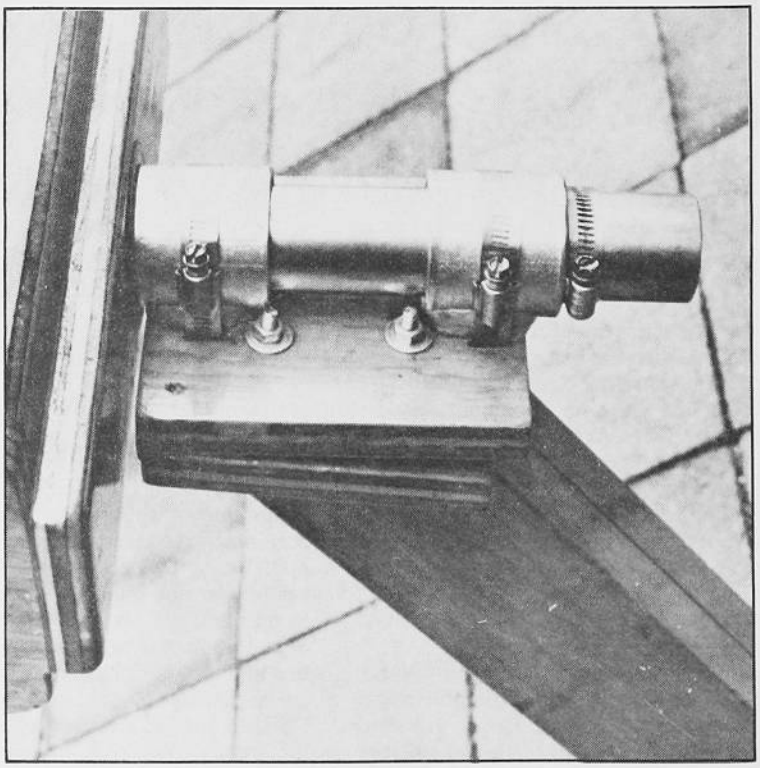
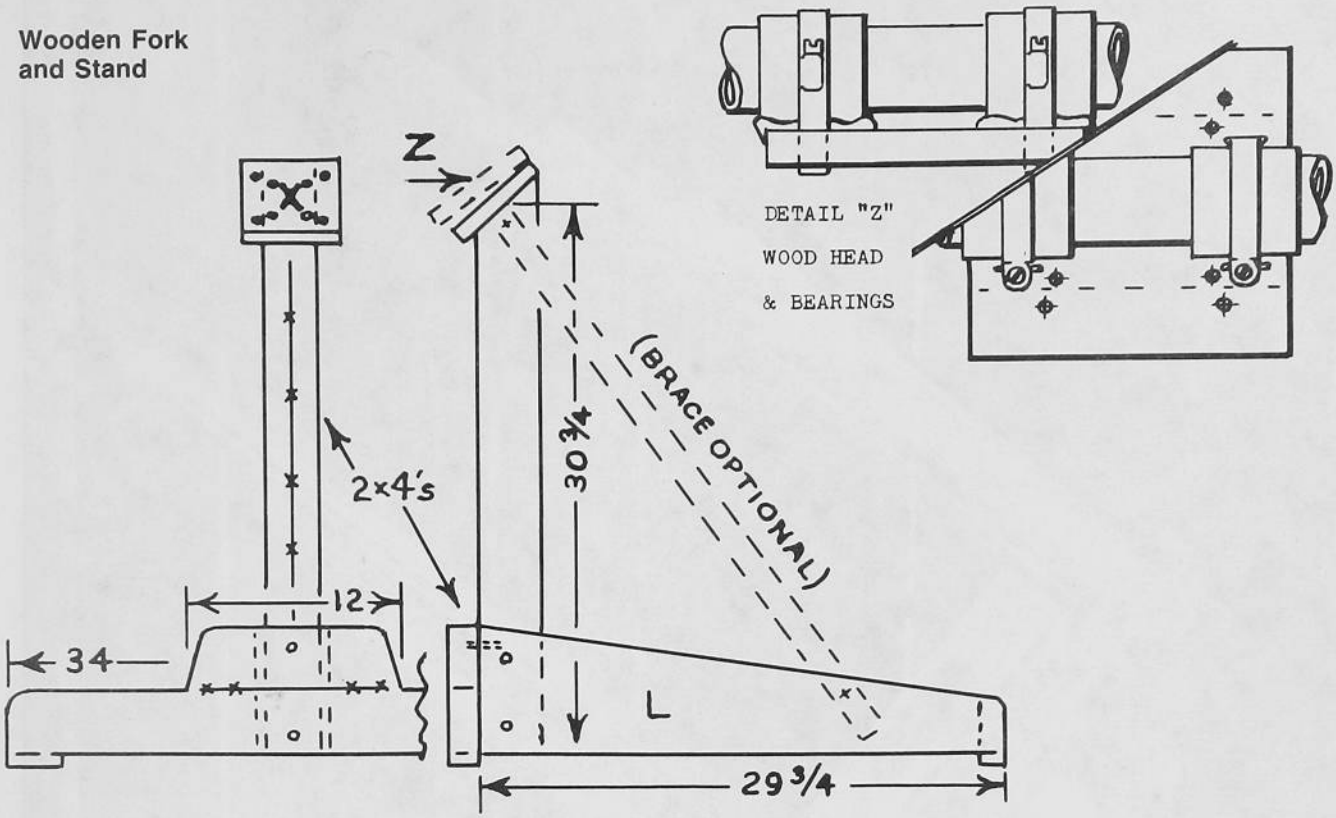




Wooden Fork and Stand



relatively smooth shafting. Some kind of calipers should be used to check the *motionless* shaft for roundness and size uniformity for the length of the pipe. The bearing to be used will tolerate several thousandths of out-of-roundness. Smooth to the finest (#600) wet or dry paper with light oil.

Bearings

The bearings are made from two 1½" iron pipe couplings. Bore out on a metal cutting lathe, or grind out the threads (wear goggles) with a small abrasive wheel to allow space for a plastic sleeve. 1/16" thick Delrin sheeting is inserted to bear on the smooth shaft.

Lacking the lathe and the expertise of a machinist, you could get by with estimating the material to be removed and making repeated trial fittings. The Delrin plastic is a good bearing material similar to nylon (I couldn't find Teflon) and available in a 1/16" thickness. It may be cut with a strong shear or by scoring one side with a sharp knife and snapping it over a hard edge. Short trims may be done with tin snips on tough material.

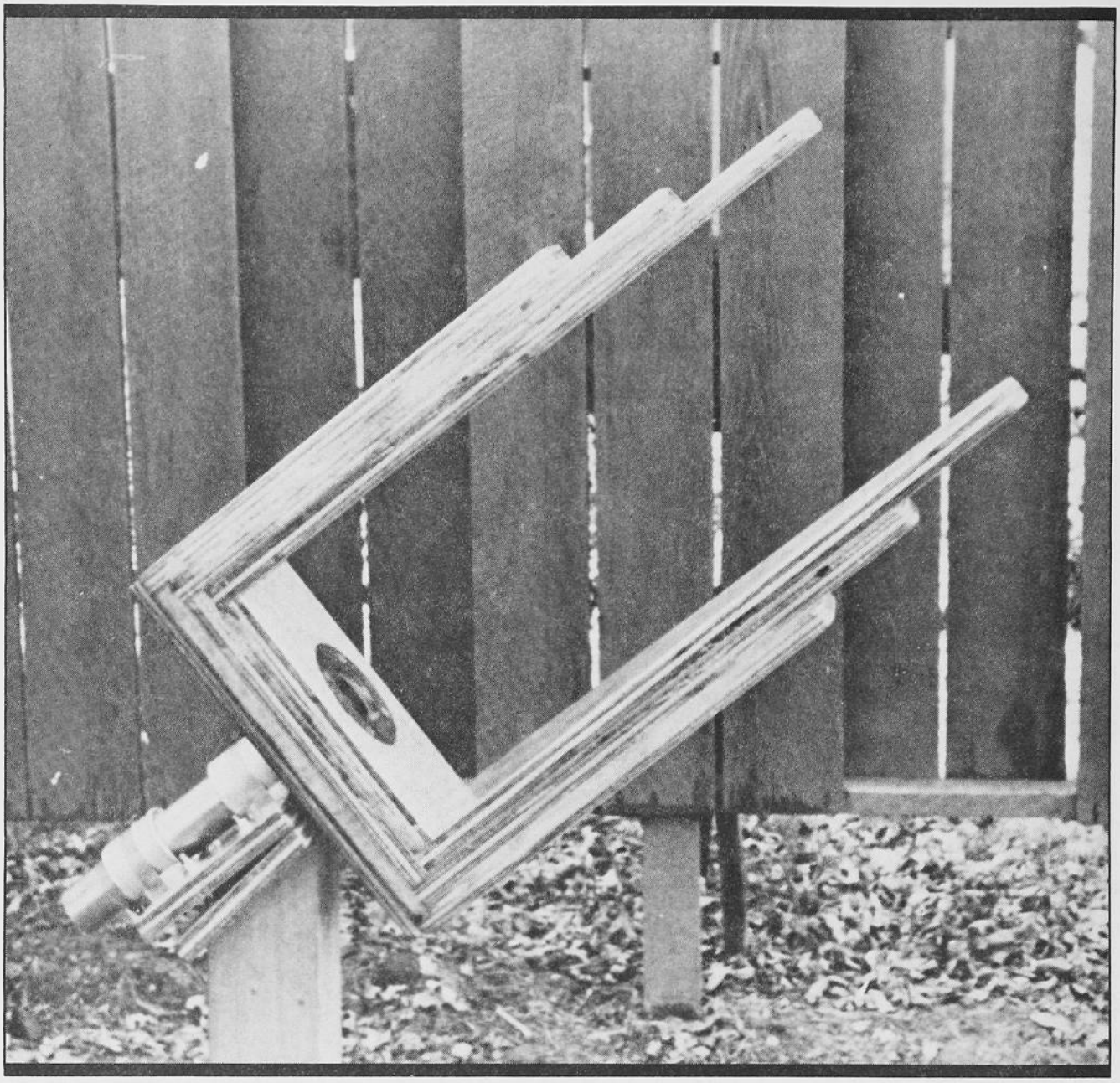
A strip 2" wide by 6" long will more than go around the smooth shaft and allow a slightly diagonal trim off each end. It is best to stay on the long side so the sleeve will fit snugly.

The strip is rolled slowly into a coil; dipping it in hot water occasionally helps to relax it. Wrap it around the pipe shaft and draw it down with a hose clamp around it. Set it in an oven at about 175°F for a while. This will indicate the amount to be trimmed, so mark this after cooling and before releasing the clamp. Coil it enough to permit inserting it in the ground-out coupling. It should snap out to conform to the inside diameter if not too long.

Now try to insert the shaft. If it cannot be coaxed to go into the sleeve, and the sleeve fits well, the coupling needs further enlarging. If it is loose, too much has been taken out but the fit can be improved later. If the shaft goes in, even if very tightly, place the shaft with the bearing in the oven again for at least a half hour. The plastic will relax and fit better. Because of variations in the diameter of the shaft, it is practical to select the bearing that best fits each end.

With the two bearings placed on the shaft, strap them down securely on a wood head with hose clamps large enough to circle around bearing and a section of wood. The head is bolted or otherwise solidly attached to the post. Epoxy the contact area between the couplings and the wood base so no rolling or wobbling can occur. Allow the epoxy to set. A good grease will lubricate this bearing better than oil.

After the fork is completed and mounted on the stand, the fork should be spun numerous times. Observe whether the action is smooth. Unevenness may be reduced by pulling the shaft out and dressing local areas that show wear against the bearing surface. Excessive looseness may be reduced. Pull out the shaft, coil out the sleeves — marking each for replacement as you do — and clean away any oiliness. Coat the inside of the couplings with paste epoxy, then reinsert sleeves and the greased shaft. Turn it to loosen any stray epoxy and let set. The epoxy shims the sleeve with more uniform support against the shaft. When set, pull the shaft again, and clean out any slivers



of epoxy from the bearing surfaces. Grease the shaft and replace. A hose clamp serves to secure the lower end of the polar shaft, quickly removable for portability. Cut washers from the plastic lids of coffee cans to act as thrust bearings between the fork and the shoulder of the upper bearings. Cut off any excess polar shaft.

Fork Assembly

The fork is assembled, glued and nailed, starting with the longest arms and the shortest base board. Screw the shaft into the flange, square the flange on, and secure it with screws to the first base board. A ¼" threaded rod is used to space the arms apart at the declination axis. The arms must be squared both ways to the base when they are attached, and the axis of the polar shaft aligned with a marker positioned in the center of the above rod. Maintain this alignment and allow to dry overnight.

Proceed to add the next base section on the shaft, line it up square, then glue and clamp to the first assembly. Glue, nail and clamp the arm pieces to the base to fit the contour of the long arms, checking that the shaft alignment remains true. When the clamps can be safely removed, glue, nail and clamp the last of the pieces in the same way. Finally, add the bottom strip.

There may be some space around the shaft in the base; this must be filled in the lower part to prevent any play. Unscrew the shaft from the flange and pull it out of the fork. Paste epoxy is smoothed to the insides of the hole for at least an inch, the shaft greased and reinserted, and then screwed into the flange snugly (do not use a wrench — a firm hand grip should do it). Push some epoxy in around the shaft with a thin blade and clean off.

Finally sand all the edges to a smooth contour, fill any voids with plastic wood, and round corners as desired. Finish the fork with a coat of linseed oil and let it dry several days, then sand and apply several coats of spar varnish. Outdoor primer and enamels may be used, too. The base sections must be constructed to give solid support and portability when unbolted; careful fitting will accomplish this.

A.L. Woods
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■

Letters

Where to Find Big Blanks?

I enjoy TM very much and look forward to each issue, and I guess I'll never stop making telescopes. Although I've made many achromatic lenses, I've never made one over 4.5" diameter. I would like to go for it and try a big one, something in the 8" to 12" range. I'd like to hear from people who have already done this, as I'd like to discuss many things.

Second, where does one obtain such glass?

Raymond Reiffer
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— Any help readers can offer would obviously be appreciated. We'd appreciate receiving a copy of your letters for possible inclusion in this column.

Kudos and a Problem

Dear Richard / A couple Kudos and a problem. The problem first. Almost two years ago I wrote to some of the larger mirror companies asking about prices for a mirror in the 20" to 24" range. I got a near-instant reply from a very well-known company that said that while they do not do custom work, they had one of their 1979 vintage stock 20" mirrors left and they would ship it on the receipt of the full amount, which seemed fair. I sent them my money, built a massive Dobsonian, and waited. I was confident. I mean, this company has/had a great reputation. Since then I've written them half a dozen letters and phoned them half a dozen times. Seems they decided to regrind the mirror. Now they've scratched it. And it seems that they don't have any of the equipment for a 20" left and have to rebuild their entire shop. I'm sure this mess will be resolved some day. Every three months I'm told the mirror will be shipped within three weeks. What can I do? What can others do to prevent this kind of thing from happening to them?

To balance this letter with a positive note, a couple companies are providing flawless, amazing equipment that I think has revolutionized amateur astronomy as much as Dobsonian mounts have. I'm speaking of Tele-Vue and their eyepieces and Lumicon and their filters. The first time I used a Nagler on my 12.5" f/6 it was like using a whole new telescope. I cannot over-emphasize the importance of good eyepieces in the optical train. They are, after all, an equal partner in all that you see. I now own five Tele-Vues: 40, 32 and 24mm Widefields and 23 and 9mm Naglers. Each is a wonder.

As for Lumicon's filters, I spotted Halley on October 17 from my observing position under a brand-new street light in the alley and in a sky illuminated by the biggest shopping center in the world, less than two miles away. Progress. I've traced the nebulosity in Orion and in the Veil across full degrees of sky. Their filters are magic. More pertinent to TMs is their enhanced silver diagonals. I use them in all my telescopes and they do make a difference.

Also, I have to say how impressed I am with Novak components. I've used Novak spiders in four telescopes now, ever since my own homemade and (I thought) sturdy spider gave up one night when I was moving my 12". You have never really lived until you've heard a 2.5" diagonal fall six feet and shatter against the face of your 12" primary. Novak makes a lot more spiders than are listed in their catalog. Ask them about their Extra-Super-Ultra-Heavy-Duty jobs. They're great.

And, lastly, TM has been an endless source of inspiration for me, especially TM#23 and 24 and Allen's solution to the problem of fork arm flexure. What was a year ago a mirrorless 20" Dobsonian is now a mirrorless 20" fork equatorial, waiting on its trailer, ready to roll. So much of that telescope is (or will be) a product of TM magazine. I can honestly say that without TM it would not have been built. Anyway, keep up the great work and tell Kalmbach to give you all raises. You deserve them.

Jay Kirkland
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— Thanks for your comments. Long waits for mirrors are not exactly uncommon. My own 20" took about three times longer than predicted, but I am a cynical type and expected the delay. In passing, let me add that re-reading King's The History of the Telescope *will reveal your problem is not a new one. Jesse Ramsden may*

◄3

holds a special interest for telescope makers. It was a very different place in 1936, when I first attended (I didn't have a camera until 1937). Last year, more than 2,000 people came to Breezy Hill. It is obvious that Stellafane is outgrowing its limited land area and I hope the fund raising drive they plan will soon result in much larger display and meeting facilities.

The Tucson National Meeting of the Astronomical League had limited telescope sessions and displays. What they did have allowed me to discuss optics and exchange new ideas with people from many parts of the country. I chaired a workshop on "New and Exciting Optical Designs for the Amateur" to inform those attending of the latest trend in improving telescope performance by specially designed accessories, in particular, eyepieces that compensate the coma and spherical aberration in the exit pupil to yield outstanding performance.

The Astrofest meeting, held last year on September 14th at Kankakee, Illinois, is a special meeting attended by many Midwesterners interested in telescopes and observing. Instruments displayed had both homemade and commercial optics, with a reasonable balance between them. There were more commercial instruments set up at Astrofest than I saw at Stellafane, in particular SCTs, but these were for observing with one's fellow amateurs.

Astrofest gives awards for innovative telescope designs. Astrofest also has door prizes, but none of the expensive variety given at Riverside. This is because there are few commercial exhibits, probably due to the mid-September date and the lack of Midwestern vendors.

At these meetings, I was impressed again and again with the lack of amateur optics. The art of making one's own optics has slowed in the United States due not only to the cost factor but also to the availability of materials, in particular glass disks. I do not believe that the hobby will die out, but it sure needs a shot in the arm. One thing that would help would be more enthusiasm from those with the experience to teach others. It is a proud achievement to be able to say that the instrument has optics that were made by the owner.

Although it is also a good feeling to be able to say that the instrument was made by the owner using commercial optics, the difference is great. If using commercial optics is like a B.S. degree, then for aspiring Telescope Nuts, making your own optics is equivalent to a Ph.D!

Where's the challenge, the learning experience, the thrill of knowing the mirror was made by the owner, if one purchases it? Many former amateur telescope makers — myself included — found this hobby can lead to an occupation. I felt that the exhibit of grinding, polishing, figuring, and silvering of a 6" mirror at Stellafane this year was a big step in encouraging people to join our hobby. The workshop on mirror grinding at Astrofest also provoked a great many questions and hopefully inspired some of those present to accept the challange of making their own optics.

I believe the future holds new and exciting possibilities for the amateur astronomer and serious telescope maker. New designs will simplify fabrication and encourage people to make optics for their instruments. The development of new accessories, in particular eyepieces designed to cancel residual aberrations at the focus of an instrument, will yield almost perfect performance. This trend has already begun and will continue.

And how will all this take place? Through you — the amateur telescope maker — reading this article and this magazine, accepting new challenges, and obtaining higher goals of endeavor.

— Robert E. Cox, T.N.

Letters

◄3

have been the outstanding example. I trust that your experience will guide others in their delivery time expectations.

I'll pass that last suggestion along.

Martian Craters

Dear Richard / In the Letters column in TM#26, Dick Nelson asks about John Mellish and observations of Martian craters from Earth. I've done considerable research into this topic, including an article for *Icarus* in 1976 and an article in *JALPO*, Volume 25, Nos. 9 and 10, October 1975. A more complete article was published in Patrick Moore's *1983 Yearbook of Astronomy*. Since not everyone has access to these publications, I'll provide a brief synopsis here.

The following predictions about craters on Mars were made by at least five people: W.H. Pickering (1892), D.L. Cyr (1944), R. Baldwin (1949), E.J. Opiks (1950), and C. Tombaugh (1950). In addition, Antoniadi suggested the possibility of volcanoes on Mars, as did D.B. McLaughlin in 1955. C. C. Slipber also wrote about the possibility of volcanism on Mars in 1955.

The following persons actually saw Martian craters telescopically from Earth: E.E. Barnard (1892), John E. Mellish (1916), H.P. Wilkens (1954), and Percival Lowell (1903). Barnard used the 36″ refractor at Lick; Mellish and Wilkens, the 40″ at Yerkes; and Lowell, the 24″ Clark. Lowell did not realize what he had seen, but his description of Ascraeus Lacus (now called Ascraeus Mona) shows that he actually saw the summit caldera. I have sent similar information to Mr. Nelson. H.P. Williams describes his and Mellish's observations in his book *Mysteries of Space and Time* (1955), and republished them in the *Smithsonian Treasury of Science*, Volume 1 in 1960.

When it comes to discovering craters on Mars, Mariner IV (1965) has to take a back seat!

The photo of Mellish's drawings shows the last surviving ones. All were done with the Yerkes 12″ refractor, except for January 7, which was taken with the 40″. The ones showing the craters apparently were destroyed in the 1964 fire which ruined his telescope business.

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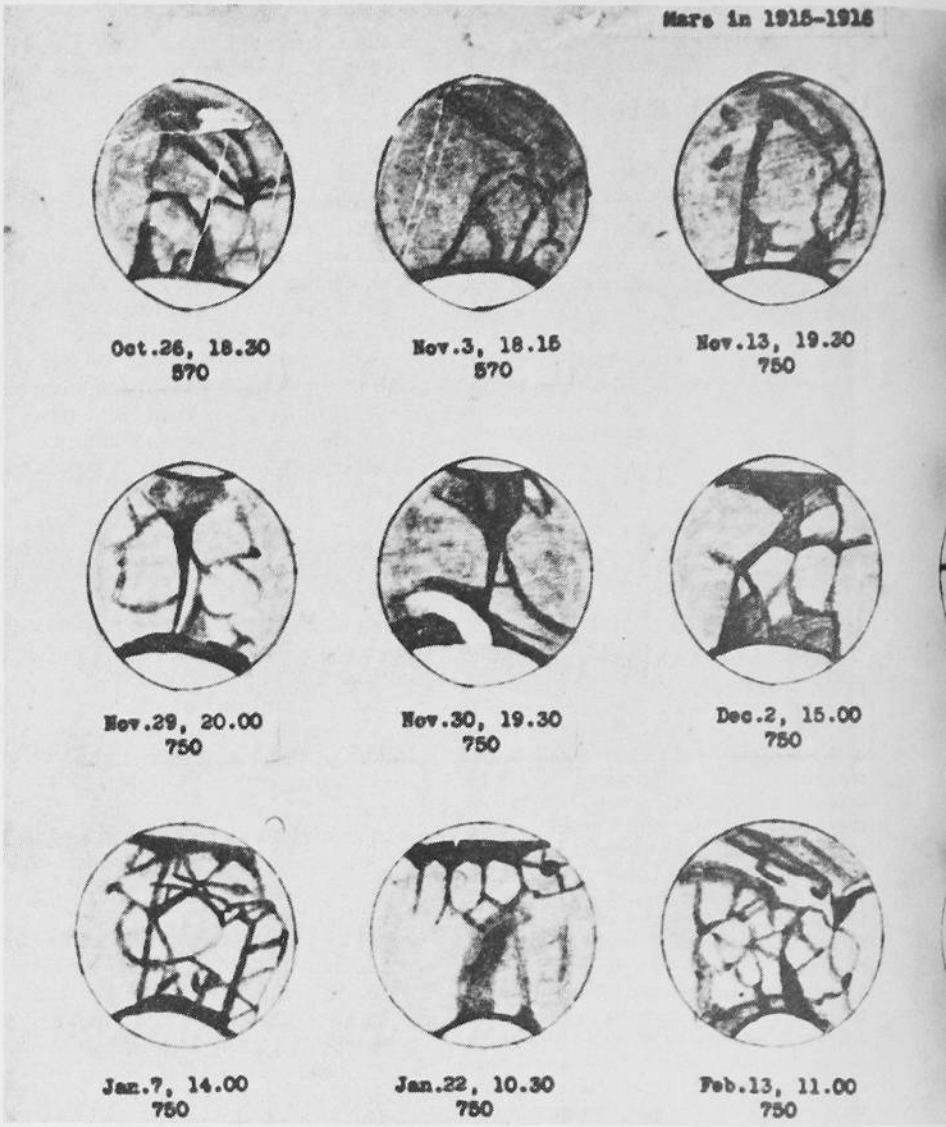
Even More Martian Craters . . .

Richard / The letter about visual observation of the craters on Mars in TM#26 called to mind a footnote by T.E. Espin in the Dover reprint of *Celestial Objects For Common Telescopes* by T.W. Webb. On page 1973 of Volume 1, the footnote reads: "A number of small dark spots have been seen by W.H. Pickering, and have been called OASES. He believes them to be craters, and the "canals" are cracks radiating from them, as in the case of some in the moon. Carbonic acid escaping from them might cause a low form of vegetation on either side of them, and so



render them visible. It is worthy ot note that the last remains of volcanic agency takes a form of the emission of carbonic acid."

Since I noticed this note some years ago, I have kept my eyes open for any other pre-Mariner references to craters. However, your anecdote is the only one that I have come across. Gibson Reaves (USC Department of Astronomy, University Park, Los Angeles, CA 90007) might be a good person to contact to follow-up on pre-Mariner crater references at Lowell Observatory. I know he has spent quite a bit of time at Lowell in recent years doing historical work. Perhaps he has heard of a reference that might be useful.

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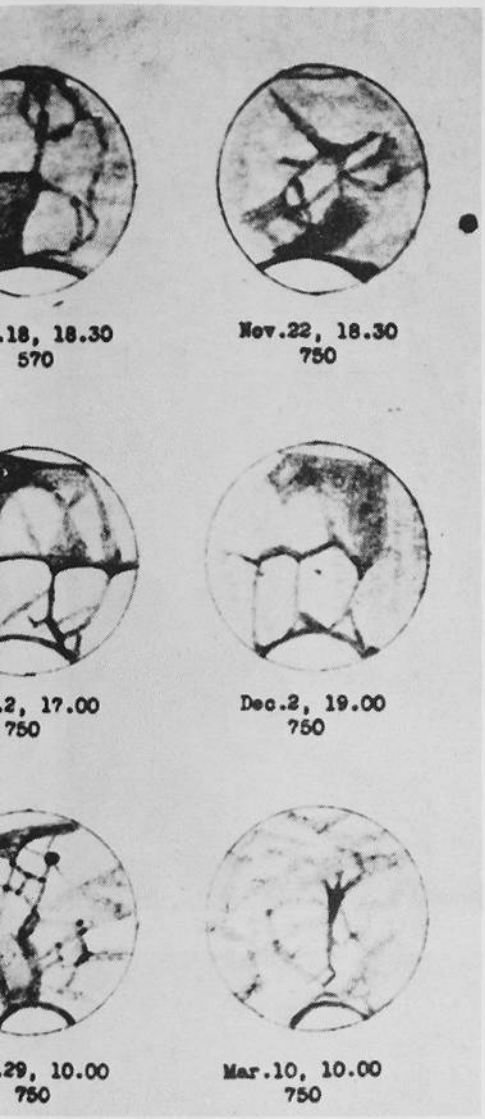
More on Apodizing (Argh!)

Dear Richard / I was glad to see in TM#26 that Art Leonard had done some calculations on the apodizing mask controversy. He agrees with my conclusions about screen-type apodizing masks and their affect on the "viewing," telescope resolution, and on the non-affect on the seeing. However, I felt the letter was disappointing. Instead of reporting on experiments to verify his claims, he resorted to a "realm of consciousness" discussion containing no new data. I will briefly answer his points in the order in which he makes them:

Paragraph 2: That I didn't consult the literature is false. My references go back to 1951 (TM#24, page 17). Jim's references from the early 1980s unfortunately give almost no information, and Jim doesn't tell us where to find these references in this letter. He does give us the magical screen radii that are supposed to work, but there's no hint as to the criteria or methods used to select the radii or the screen type and wire size and spacing. There's no way that anyone can test his results. The radii I selected for my three screens are 70-80-90, not the 25-50-75 Jim says I used. My 70-80-90 screen is close enough to his magical values that it should show some beneficial effects if there are any.

Paragraph 3: If you can't understand apodizing under ideal conditions you surely can't understand it in imperfect circumstances. I discussed both and found



Alles geben die Götter, die unendlichen,
ihren Lieblingen ganz,
alle Freuden, die unendlichen,
alle Schmerzen, die unendlichen, ganz

(Johann Wolfgang von Goethe)

ANTON KUTTER

13. Juni 1903 1. Februar 1985

In Dankbarkeit und Liebe

Claus Kutter
Adrian und Hannelore Kutter
Floriane Kutter

7950 Biberach/Riß, Waldseer Straße 3

Seinem Wunsch entsprechend fand die Trauerfeier
in aller Stille statt.

In seinem Sinne bitten wir anstelle von Blumen um Spenden
an das Pestalozzi-Kinderdorf Wahlwies, 7768 Stockach 14,
Konto-Nr.: Bezirkssparkasse Stockach 6 007 694 (BLZ 692 517 55)

that apodizing can't improve astronomical seeing as seeing is commonly defined.

Paragraph 4: Contrary to Jim's statement, photographic results are highly relevant. They provide unbiased data showing no improvement in the seeing when the aperture is modified. I fail to see how a screen that acts as a seeing filter could act only on not-too-bad seeing. Either it works or it doesn't. The source and "quantity" of seeing shouldn't matter.

Paragraph 6: Jim's perspective on audience reaction at RTMC '84 is strongly colored by his own biases. Seeing if bumblebees can fly is important to entomologists but irrelevant to apodizing.

Paragraph 9: I won't dispute Jim's quote from me, but it is not true that I examined his screen and took notes. I had nothing to write with or on; it was dark, and I felt no need to anyway. Upon reflection, I realized the improvement in the "viewing" with his screen could be explained by the difference in its transmission compared to my neutral density filters. This prompted my letter in TM#26, page 53.

Paragraph 11: Jim's statements are contradicted in Art Leonard's letters that follow Jim's letter in TM#26. At least Art and I have analyzed apodizing masks, which Jim apparently hasn't.

Paragraph 16: Jim's lack of understanding of the scientific process is apalling. My analysis is not based on guesswork. It involved mathematical computations, laboratory studies, and observations at the telescope. Details were given so that others could duplicate my work and extend it; I even suggested that follow-on studies are necessary. Jim apparently prefers to blow smoke and rely on guesswork rather than prove his claims with a careful, unbiased investigation.

In closing, readers should understand that my purpose in analyzing and testing apodizing screens was to see if the claims made for them are true and quantifiable. By the strict definitions of the words used in praise of them, mesh screens do not and cannot match these claims. I encourage others to go out and make some controlled tests to find out for themselves and report to the rest of us what they find.

My results do not mean that people must stop using mesh at their entrance apertures. The screens do reduce glare and thus improve "viewing" (not the seeing or resolution). My point is that other methods — a neutral density filter or observing in twilight — will also improve the viewing to the same or greater degree while not degrading the resolution of the telescope; only so-called rubber mirrors (presently unavailable to us) will improve seeing.

I strongly feel that subjective claims made for mesh apodizing masks should be carefully examined. I have done that based on a careful study of selected screens and their effects. I hope that any further discussion will have less rhetoric, greater accuracy, and more scientific data.

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Bardou Refractor

Sirs / I am looking for information on the origin of an antique Bardou refractor that

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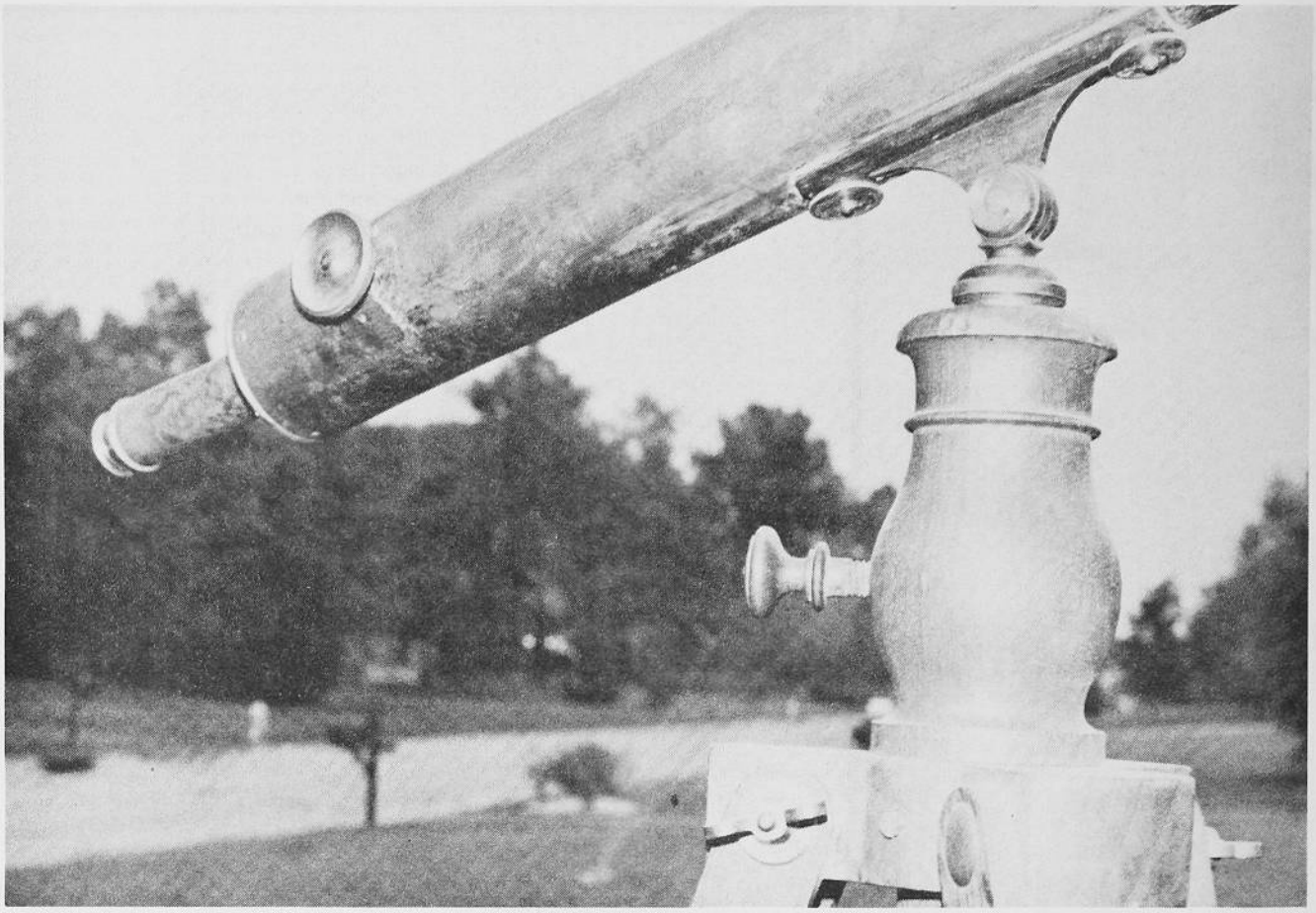

someone lent me. I have made inquiries at Stellafane and to several other sources and have received conflicting reports as to the instrument's age and construction. I understand that Bardou is a fairly well-known name, so it probably shouldn't be all that difficult to track down information on the instrument.

As a newcomer to the world of antique telescopes, however, I'm not sure just where to begin. If readers could provide me with the names of any books, articles, people or institutions that could help me in my search, it would be greatly appreciated.

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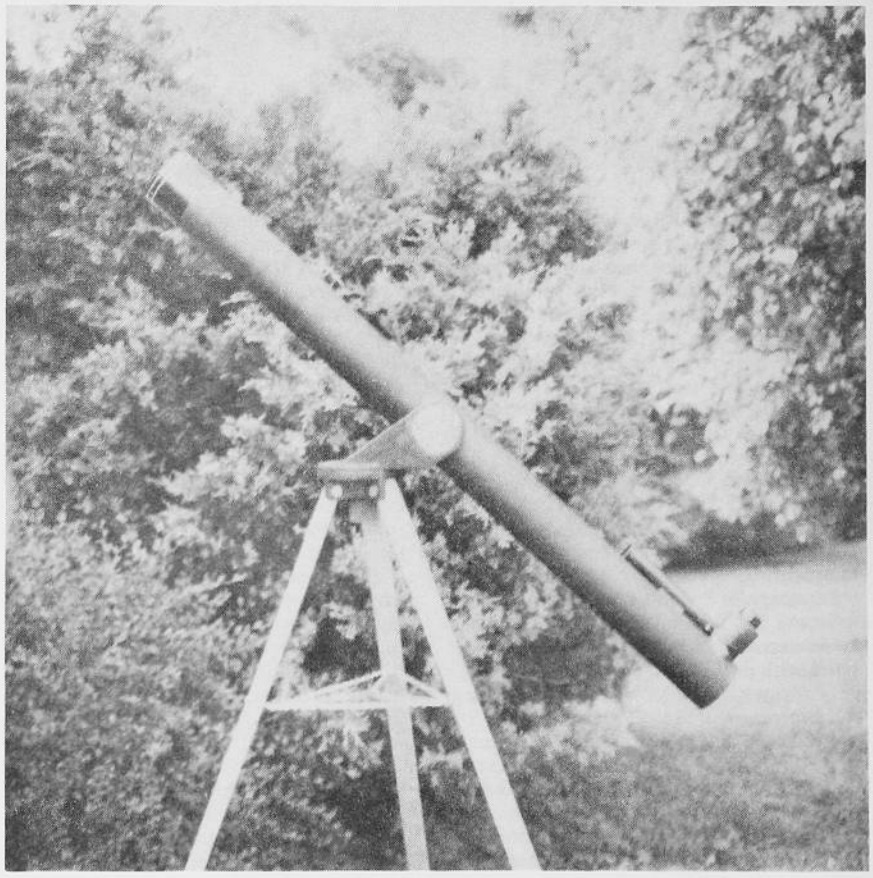
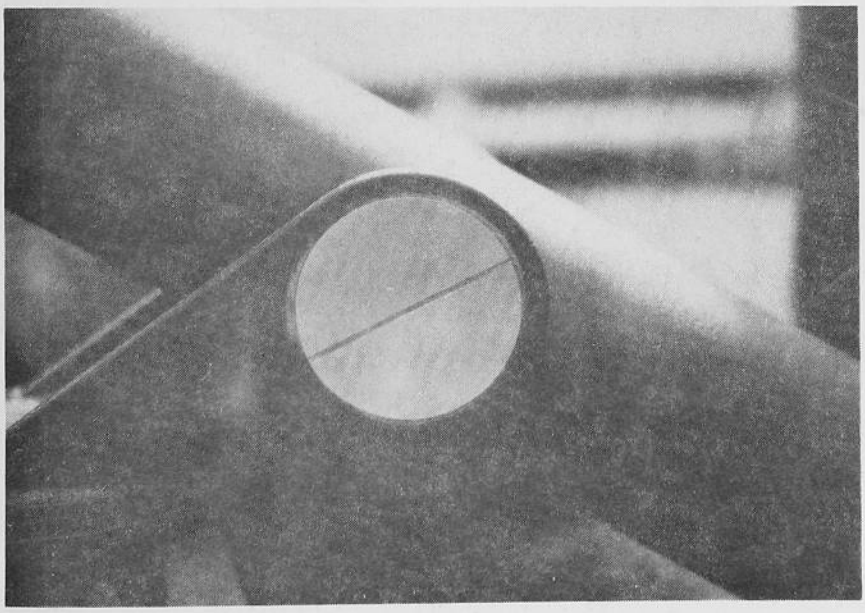
Remembering the Skyscope

Dear Richard / In TM#25 you carried a picture and some comments on the old 3.5" Skyscope. Actually some pretty well-known observers got their start with one of these. Philip Budene of ALPO was one, and he's been a Jupiter recorder for many years. Another was James Bartlett of ALPO, who studied crater formations near the lunar limb in the early 1950s, resulting in the changing of the maps of that region. *Scientific American* mentioned these studies in 1952. H.P. Wilkens, foremost lunar authority at that time, named a crater after Bartlett. Joseph Liu, the well-known observer from Hong Kong, started off with a Skyscope. A picture





of him with his Skyscope and some lunar photos he took with it appear in *A Guide to Astronomy* by Lloyd Mallan. Incidentally, anyone from today's generation who thumbs through the book and looks at the ads is apt to get sick when they see giant war surplus 32mm 68-degree Erfle eyepieces advertised for $18.50, or read how to build a satellite telescope for $9.95. No bargains like that anymore!

Back in the mid-1950s, you could get a 3″ f/10 Dynascope reflector for $27.95 and a 4″ f/11 for $44.95. The mirrors were parabolic, too. The 3″ came with two eyepieces and the 4″ with three eyepieces. A friend of mine bought a 4″ for the 1956 Mars opposition and it worked quite well. The 3.5″ Skyscope sold for $29.75 and eventually went to $44.95 before they stopped advertising in the early 1960s. Those prices might seem incredibly low today, but if those instruments were still being made they would go for $200.00 to $300.00.

I recently told you about my 3″ f/15 Brandon refractor. Enclosed are some photos that might be of interest. Note the screw-on dust cap. A similar cap in the rear holds a permanently aligned mirror-type built-in star diagonal. The 3″ f/15 Brandon was first made in 1948, so it had a built-in diagonal six years before Questar hit the market in 1954. In 1954, the 3″ Brandon sold for $196.00. At that time the Unitron 3″ f/16 alt-azimuth went for $265.00 and Edmund Scientific had a 3″ f/15 at $195.00. They later dropped the price to $125.00. The Edmund 3″ was on an equatorial mount.

Note also the very large 2.5″ altitude bearings and the 5.25″ azimuth bearing. Since the scope weighs about 17 pounds, these large bearing surfaces result in extreme rigidity coupled with fingertip pressure smoothness. The focusing mechanism is heliacal and stainless steel pins hold the tripod legs to the mount. Contrast these pictures with the typical alt-azimuth (or even equatorial) mounts on most of the imported Japanese "department store" refractors sold at outrageously higher prices today. They can't begin to compare with this type of quality. Anyone producing this instrument today in the U.S. to sell at a profit would have to ask $1,000.00 or more.

The 1954 Brandon was also sold with a wooden carrying case. The barrel is dural, or duraluminum, as it's called now. To keep the 5.25″ azimuth bearing surfaces smoothly operating, I use a small dab of Lithium-Molybdenum grease about once a year on the surfaces. The 2.5″ altitude bearings have slits for adjustment, should this become necessary, and that is about all the maintenance that's required.

Since alt-azimuth mounts are again becoming very popular, especially with reflectors on the Dobsonian type of alt-azimuth, anyone contemplating the building of a 3″ to 5″ refractor would do well to consider an alt-azimuth type mount over an equatorial. The alt-azimuth mount is less expensive and bulky, and, if it's made properly, can be as rigid and smooth operating as any equatorial. Maintenance and upkeep is also low. Perhaps these photos will give some ideas to anyone contemplating construction of a small refractor.

As you can see from the photo, a large knurled knob holds the mount to the tripod. On the inside of the knob is an adjustment for increasing or reducing tension for motion in azimuth. I have found it necessary to adjust it only once in three years, despite the fact that it is over 30 years old.

Chester Brandon evidently graduated from KISS (Keep It Simple Stupid!) School of Industrial Design. There is very little that can be wrong with instruments like these. Many of today's instruments have many small parts that are subject to constant wear. It's a pretty good tribute to a man who was responsible for the optical design of the Norden bomb sight that his instruments still hold up and still perform in an outstanding manner over 30 years later.

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An Interference Test for Schmidt Corrector Plates

Since I became interested in telescope making nine years ago, I've often thought of making a Schmidt camera. With Halley's Comet rapidly approaching, I decided it was time to put my plans into action. In Britain we will have a poor show visually this time round, but photographically the comet should still be very impressive. The Schmidt camera is ideally suited for this purpose. I've not yet finished the camera, but I recently polished the corrector plate and thought it worthwhile to report the method I used to test it.

The corrector was first ground flat on both sides and parallel; the thickness around the edge varied by less than 0.002mm. In order to polish the thin plate, it was necessary to support it on a thick, flat disk of about the same size. Not having such a disk, I decided to make an optical flat first before attempting the corrector. This was very interesting in itself and I now have three optical flats — a valuable spin-off!

The flats were tested by interference using a helium-neon laser in a setup similar to that described in *ATM Book 3*, page 156, by R.E. English. The test shows a series of bright and dark lines, or fringes, on the two disks in contact. These fringes can be thought of as contour lines showing the shapes of the two surfaces. When two unsilvered flat mirrors are placed in contact, the fringes show up straight and parallel. Any bumps on the surfaces appear as kinks in the fringes. When I had finished the flats and restarted work on the corrector, I had an idea: What would the interference fringes look like for a Schmidt corrector in contact with a flat? The answer to this question suggested the straightforward test for the corrector profile described below.

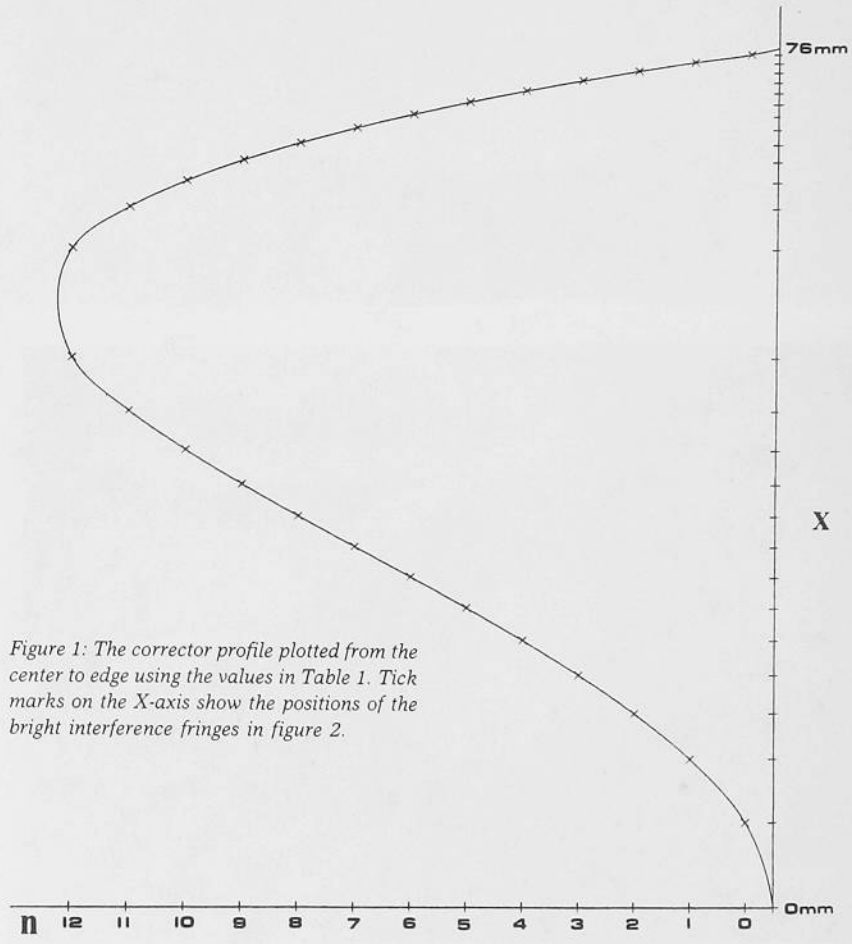


Figure 1: The corrector profile plotted from the center to edge using the values in Table 1. Tick marks on the X-axis show the positions of the bright interference fringes in figure 2.

The Interference Test

The surface of a Schmidt corrector plate deviates from flat by an amount Δ, given by:

$$\Delta = k((X^4-(Ar^2X^2)/4(\eta-1)R^3 \quad (1)$$

where X is the radius of a zone, r is the clear radius of the plate, A is a constant, η is the refractive index of the glass, and R is the radius of curvature of the primary mirror. The value of the constant k is chosen to be 1 if all the correction is put on one side (the other being flat) or 0.5 if equal amounts of correction are put on both sides. The constant A is a shape factor which in practice for small cameras is chosen to

Table 1 Corrector plate data

r = 76 mm

R = - 788 mm

λ = 632.8 x 10^{-6}mm

η = 1.52141 at 500 nm

k = ½

A = 1.0

n		x(mm)
0	7.52	75.63
1	13.15	74.85
2	17.16	74.04
3	20.54	73.17
4	23.60	72.24
5	26.45	71.25
6	29.20	70.17
7	31.91	68.98
8	34.63	67.65
9	37.46	66.13
10	40.48	64.32
11	43.95	62.00
12	48.68	58.36

make figuring easier. Figure 1 shows the profile of a plate for which A = 1, i.e., the center and edge have the same height with the maximum depth at X = 0.707r.

If the corrector is placed on top of an optical flat, the air gap will be δ. If the disks are now illuminated with monochromatic light, the light waves travel through this gap and are reflected back before they interfere; the total path difference is therefore 2 . A bright fringe will be seen if this path difference is a whole number of wavelengths; this is written as:

$$n\lambda = 2\Delta \quad n = 1,2,3... \qquad (2)$$

where n is a positive integer and λ is the wavelength of the monochromatic light. Physics books tell us that it is a bit more complicated than this, however. When light is reflected from glass, the phase is changed by ½ wavelength. When this is taken into account, equation (2) becomes,

$$(n+½)\lambda = 2\Delta \quad n = 0,1,2... \qquad (3)$$

Substituting equation (3) into (1) and rearranging gives:

$$X^4 - Ar^2X^2 - ½(n+½)K\lambda = 0 \qquad (4)$$

where some of the constants have been lumped together as:

$$K=8(\eta-1)R^3$$

in which K is taken as 0.5 (i.e., the correction is split between the sides). Equation (4) is simply a quadratic in X^2 and has two solutions:

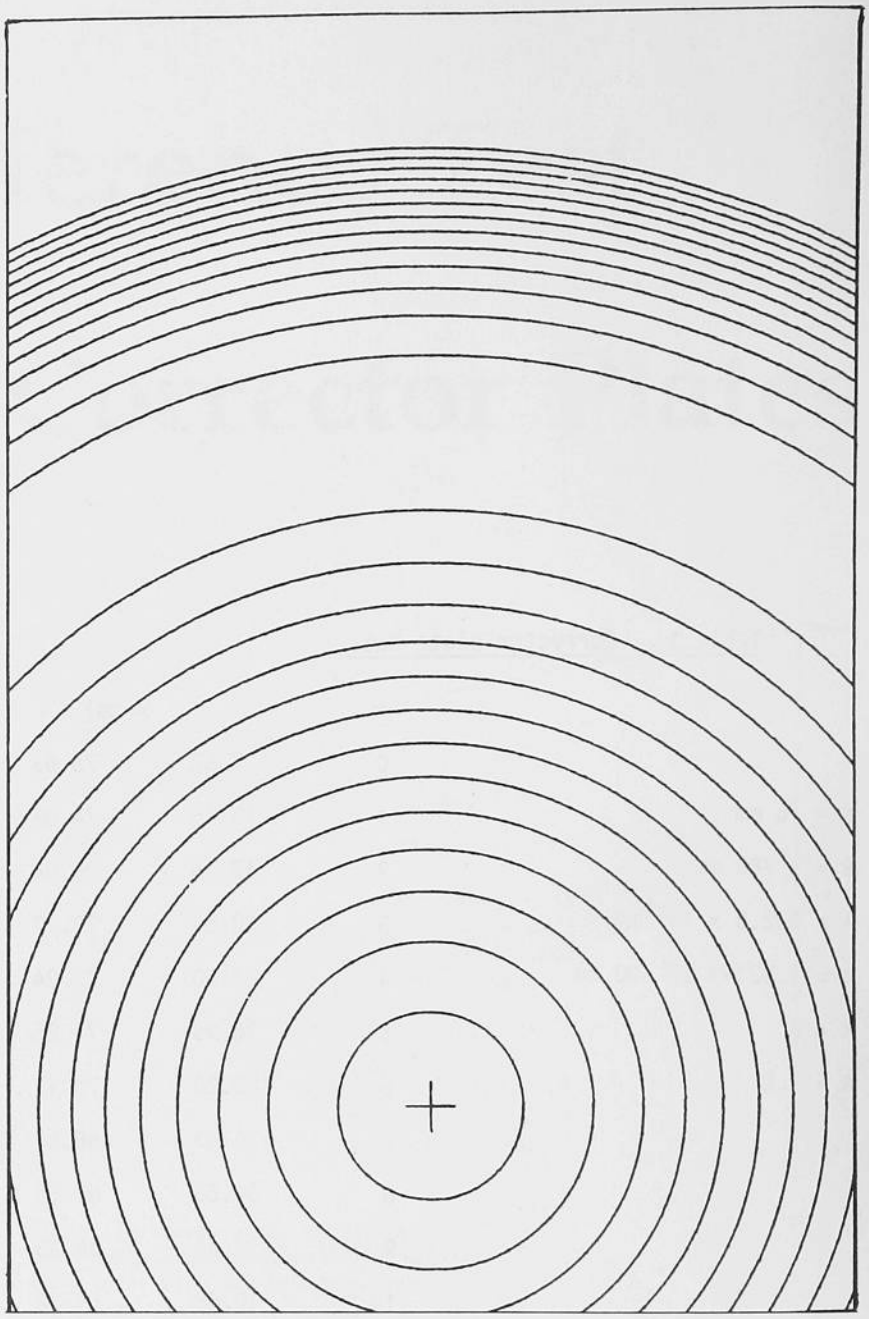
$$X^2 = \frac{Ar^2+(A^2r^4-2(n+½)K\lambda)^{0.5}}{2} \qquad (5)$$

$$X^2 = \frac{Ar^2-(A^2r^4-2(n+½)K\lambda)^{0.5}}{2} \qquad (5)$$

It is this equation which predicts the appearance of the interference patterns between corrector plate and flat, giving the radius X where each bright, circular fringe is expected. (Note that each value for n gives two values of X.)

The camera I am building will have a focal ratio of f/2.6 and a clear aperture of 6″. Table 1 gives values of X for n from 0 to 12, the maximum in this case. The figures show the profile plotted from these values and a computer plot showing the expected appearance of the interference pattern. The photograph

Figure 2: A computer diagram showing the expected pattern for the interference test with a photograph showing the actual pattern for the completed corrector. Two extra rings at the center reveal a central bump, but since this is obscured by the film holder it is left uncorrected. The slight difference in appearance between the calculated and actual pattern is due to the small air gap remaining between the disks.

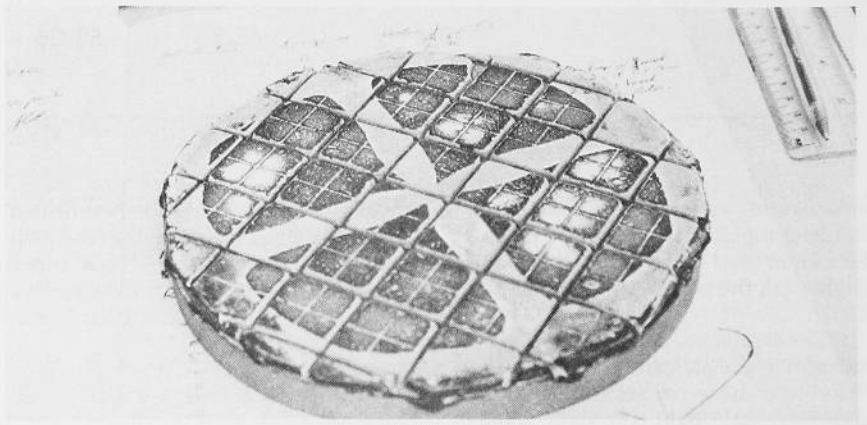


shows the actual pattern seen. The center has two more fringes than expected due to a central bump, but this is obscured by the film holder and so I left it uncorrected. Measurements from this photograph show that the rest of the plate is accurate to ¼ wavelength.

Figuring the Corrector

The classical method of figuring the complicated shape needed is to use flexible grinding tools and polishers. I had previously found that it is quite easy to polish curves up to 12 fringes deep with rigid laps, so I decided to try figuring with ordinary laps on thick glass disks.

In order to polish away more glass in selected zones of the plate only, some sort of graded lap is required. This is best achieved by making a petal type of lap with four to eight petals. The width of each petal at a certain radius is



One of the petal laps used in the early stages of figuring.

The interference pattern of a Schmidt corrector plate in contact with an optical flat. Measuring the rings reveals the profile of the plate.

proportional to the depth of the curve required. This insures that the polishing action is concentrated where it is needed. One of the petal laps I used is shown in the photograph above. Starting from a flat, polished disk, the figuring operation took about five hours for each side. The strokes used were firm, very short, and kept accurately across the center of the disk.

After each 30-minute figuring session, I checked progress by the interference test. Fringe positions were measured, plotted, then compared to the true profile. If part of the curve remained too high, a new petal shape was calculated, and its shape cut into card and pressed into a flat polisher. Work then continued. In this way, it was possible to "home-in" on the correct shape. Final accurate measurements were made from photographs of the fringe patterns.

It can be seen from the photographs that the fringes become very close at the edge of the plate. Because of this they became difficult to measure, limiting the usefulness of the interference test. From equation (1) it can be seen that Δ increases very rapidly (as R^{-3}) as the focal ratio decreases. This probably puts a lower limit of about f/2 on cameras that can be tested in this way, but for cameras of f/2.5 and above it is very easy to carry out.

Acknowledgments

I would like to thank Mr. Robert Kelly for his helpful comments and for producing the computer diagrams, and Dr. Tom Hunter and Professor Norman Sheppard of the University of East Anglia for the use of the helium-neon laser.

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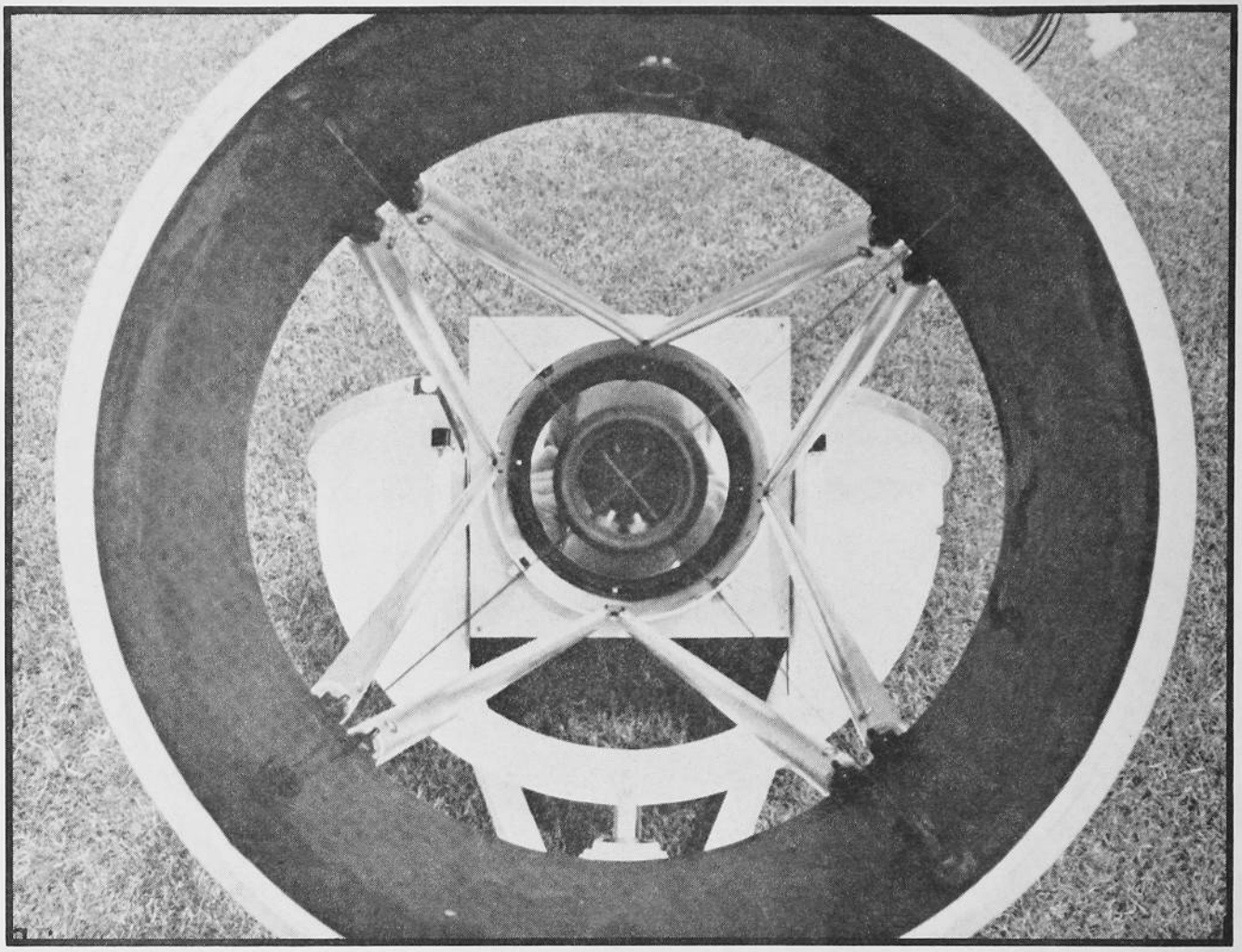
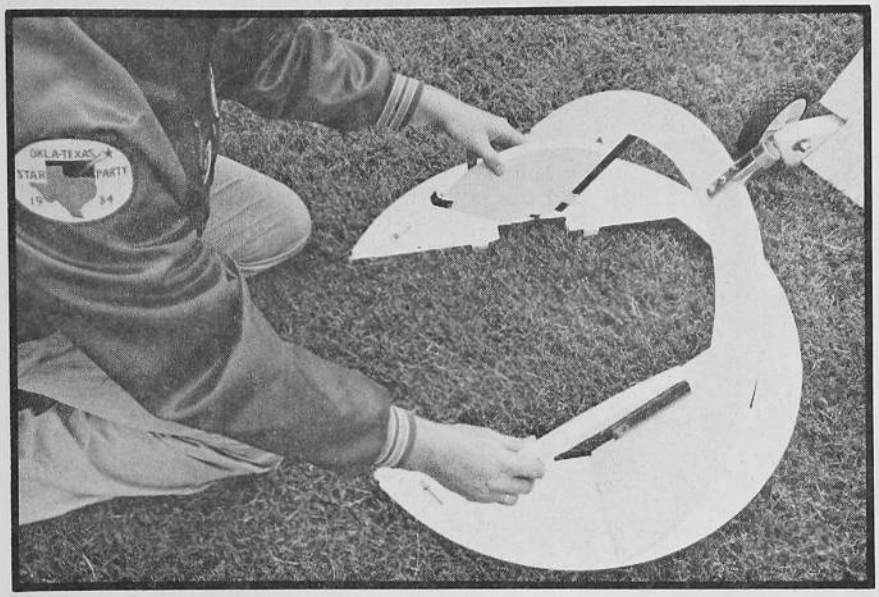
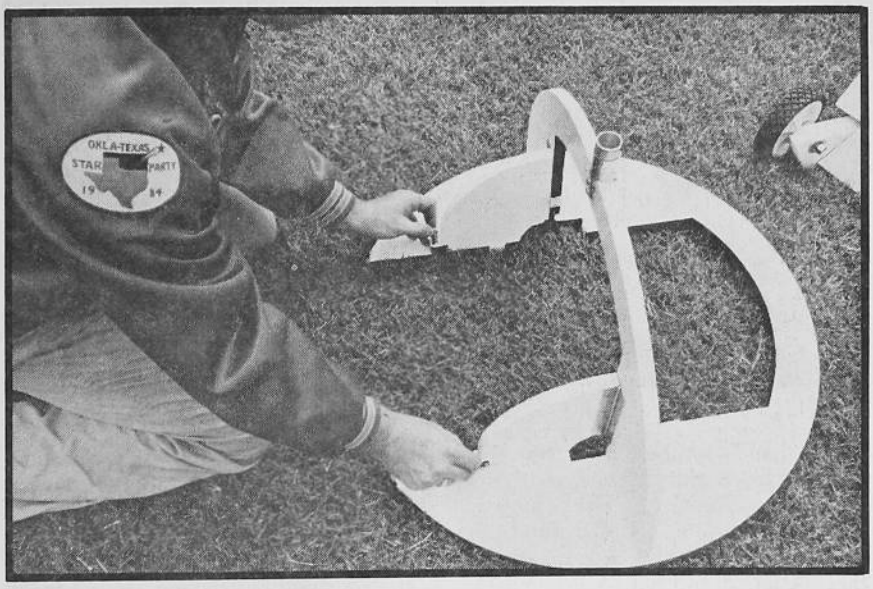
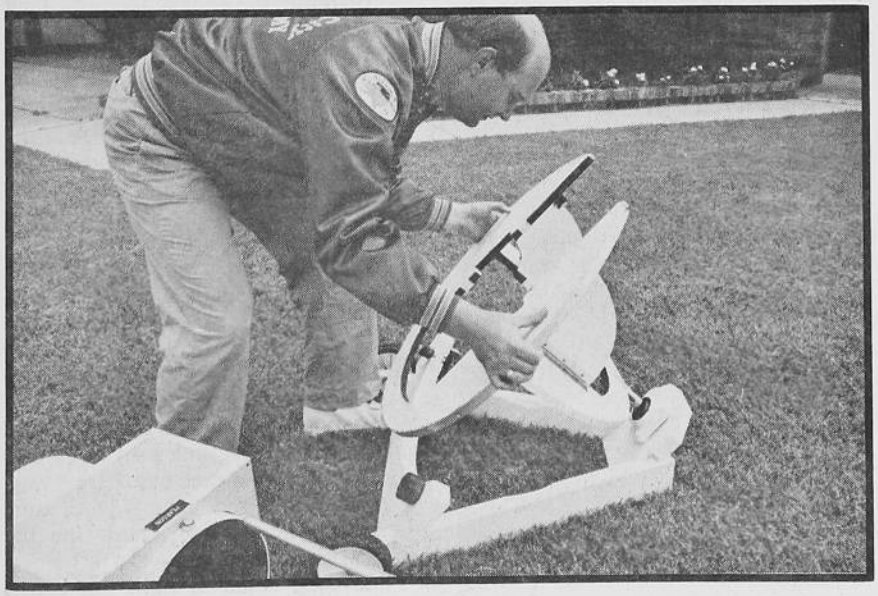


An Equatorial Split-Ring Telescope

I enjoyed my homebuilt Dobsonian. It was so much fun to use, and its 10″ mirror gathered enough light to satisfy my curiosity about deep-sky objects. But, being an ATM, I ran out of projects! You know how it is: You rebuild the eyepiece case and make a few finders for friends, but you can't help tinkering with that telescope. I had just about decided to redo my Dobsonian from scratch when a friend, Eric Allen, suggested that I build an equatorial mount rather than another Dobsonian. That started the ball rolling! I had used Eric's 17.5″ (see TM#24, page 18) and was impressed with its stability, but it was sadly beyond the reach of my woodworking abilities. Other equatorials were far too complicated for my tastes and usually too shaky to impress me after my Dobsonian. But I was intrigued enough to do a little research and experiment with a few ideas. Russell Porter's articles in *Amateur Telescope Making* provided me with design and performance considerations, and I began to formulate criteria for my new telescope:



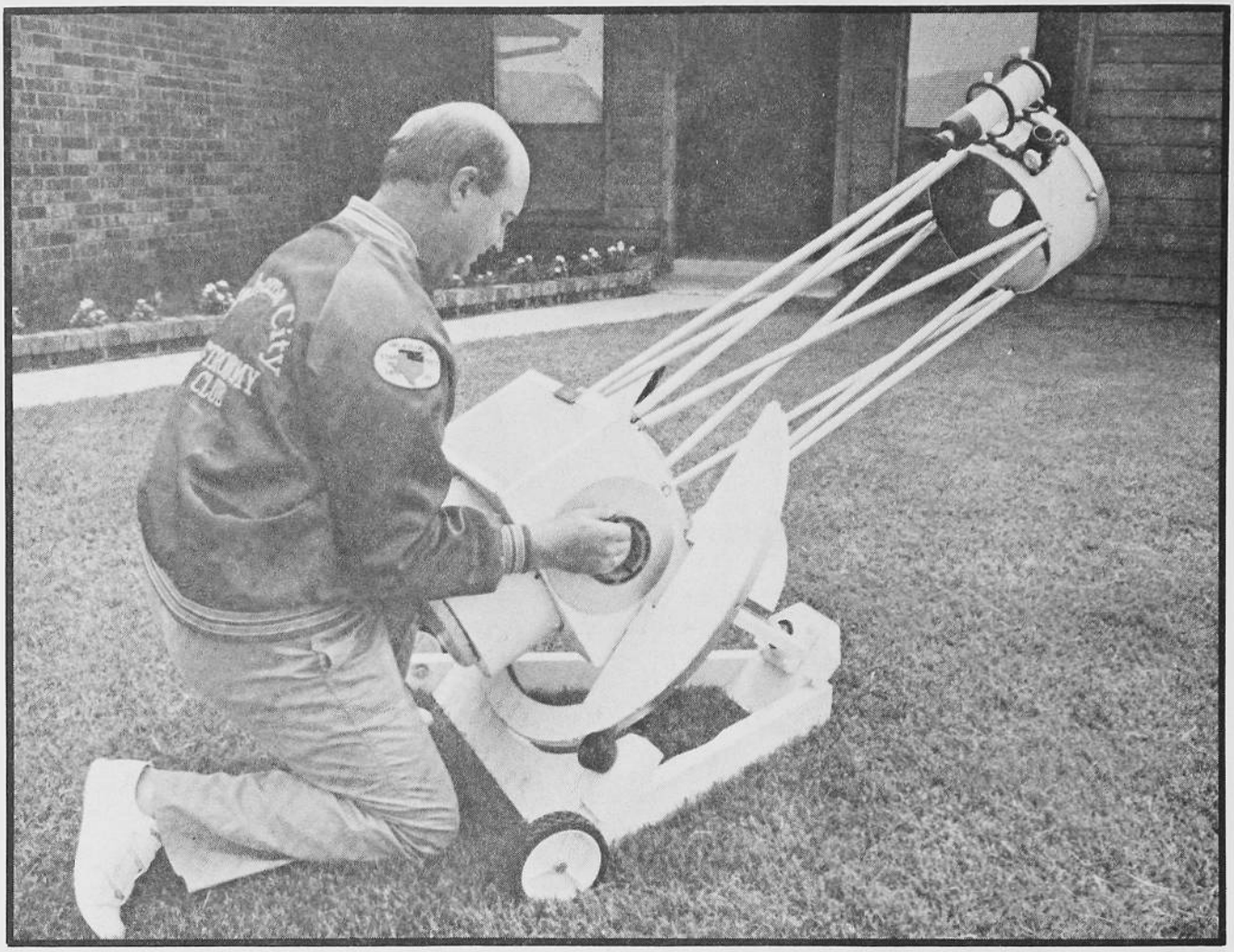




(1) It had to be at least as stable as my Dobsonian, if not more stable. Most German equatorials and English fork designs seem to have sacrificed stability for portability.

(2) It had to be driven, but the drive could not interfere with the manual operation of the scope. I personally can't see the use of an equatorial mount without a motor drive — it's like a tipped-over Dobsonian!

(3) It couldn't have any locking screws or engaging levers that would interfere with the use of the scope.



(4) After kneeling prostrate on the ground just to see through the eyepiece of a couple of German equatorials, I decided the tube had to rotate for comfortable eyepiece positioning.

(5) It had to be portable. My backyard is not the place for serious observing, so I take my "observatory" with me to a dark-sky site. And being portable, I did not want any loose parts or screws to lose in the dark.

(6) It had to be unique! I guess I wanted to have the "only one on the block" and something that I could call mine.

Well, my requirements were met in the finished telescope pictured here. Based on Porter's split-ring design, and derived from Eric Allen's 17.5"-er, this telescope is just as easy to use as any Dobsonian, but it's an equatorial, too. Let me begin by detailing construction from the top of the optical axis, which is one of the most critical areas of any telescope.

I had decided upon the open tube with a Surrurier truss because it was lightweight and strong. I also kept the PVC warm-air-duct tube from my previous telescope because it is so much lighter than Sonotube. To keep the PVC from flexing or warping and destroying collimation, I bent a ¼"-thick strip of aluminum into a circle around the upper end of the tube. The spider was then installed and bolted through the tube at the same points as the bolts, holding the aluminum ring for maximum effectiveness.

The spider is constructed from some spare brass and aluminum and the spider vanes were made from the same steel tape that is used on shipping crates. It is a permanently collimated diagonal so there are very few adjustments, although I drilled the tube holes slightly larger than the vane bolt so that small adjustments could be made if necessary. The diagonal mirror is cemented to the aluminum base with silicon glue, which seems to be excellent for this type of application. The focuser is aligned with the secondary.

From here I moved down the tube to the truss-work. I couldn't bolt the aluminum rods to the side of the tube because the rods actually cross inside the effective tube diameter. Since I had to make the tube rotate, fastening it to the tube collar was out of the question. I tried to crush the ends of the rods but the aluminum split, so I worked out a new method to attach the truss. I selected a dowel which fit snugly inside the rods and cut sixteen 2" sections to be fitted into the ends of the rods. I cut a piece of U-channel and screwed it to the dowel. After this, I simply bolted through the U-channel and the edge of the PVC for a firm attachment. Since the connections are so near the edge of the tube, the bolts also pass through a piece of steel tape on the inside of the PVC to keep it from tearing. Another screw was added for additional support.

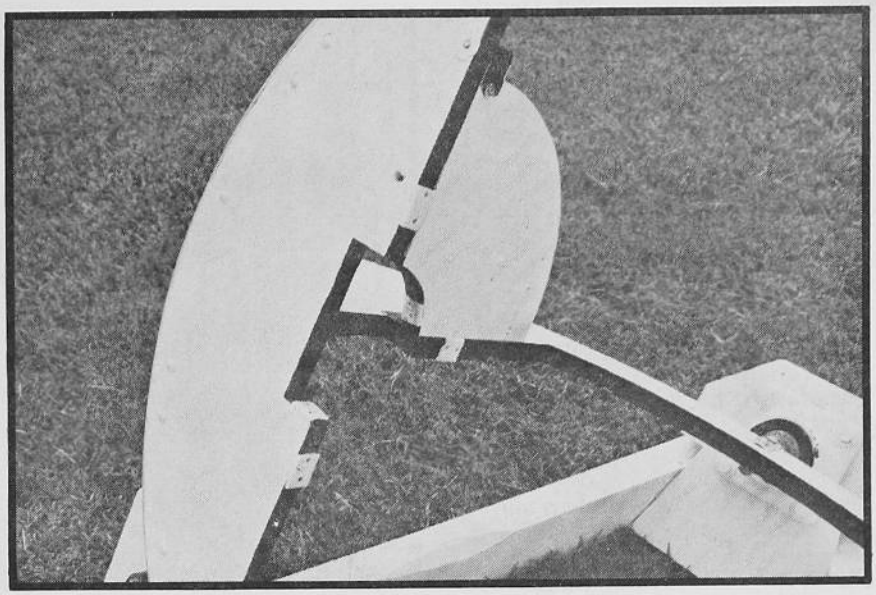
After connecting the dowels to the tube, I drilled a small hole into the side of the rods and sank a wood screw into the dowel inside. I drilled all of the top ends of the rods first, then cut a yardstick to the exact length that each of the rods should be. As I held the stick against each rod, I sank a set screw into the bottom end of each one. In this way, I made each rod exactly the same length, which is necessary for the optical train alignment.

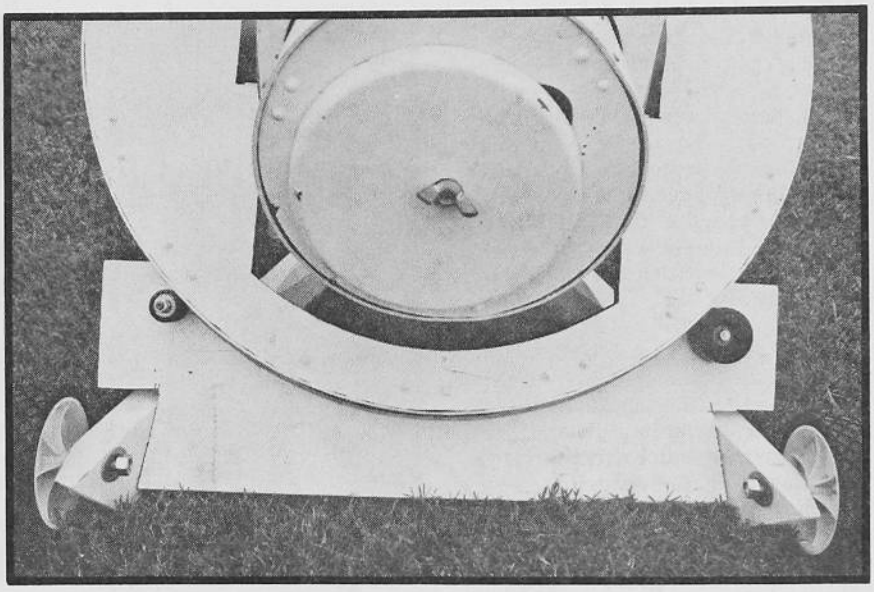
The tube collar is right out of the

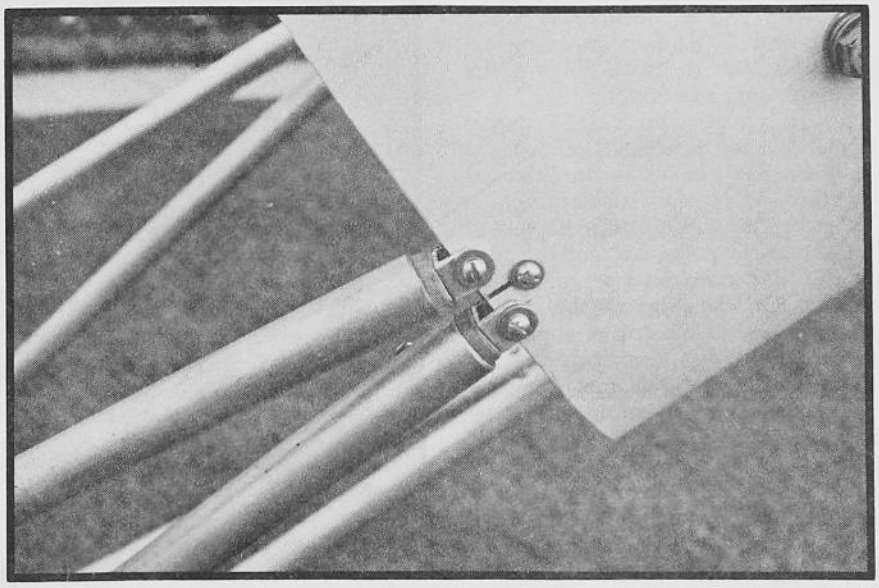
Dobsonian book, so to speak. I used video-tape reels as my declination bearings. It is important that the telescope have a smooth surface on the side of the collar because when the scope is pointed east or west, gravity pulls the bearing to the side as well as down, not just down as with an alt-azimuth bearing. Video-tape reels are perfect for a number of reasons: they are precise, smooth, and, most important, cheap. I work at a TV station and we have lots of these reels laying around, and I know that other stations have them, too. If you want a pair, just call a local TV station, ask for the chief engineer, and tell him you want a pair of old video-tape reels for your project. He will probably be glad to get rid of them even if he gives you a strange look (which I'm sure we've all had before!).

The tube collar not only supports the declination bearings but also keeps the tube cylindrical, which is important for proper collimation. The tube rests within the collar on four roller skate bearings. Since the tube is not fastened to the collar, it rotates inside it. There are no bearings on the underside of the collar because they're not necessary. The tube is always pointed up when in use and gravity pulls it down onto the bearings at all times. I put some keepers on the lower end to make sure that the collar can't slide off, but they don't normally touch the collar. I recommend you laminate the top face of the collar with Formica for durability.

My primary mirror cell is homemade and an adaptation of several different ideas. It works for me, but any style of permanent cell will work. Behind the primary mirror is the support for the counterweight. It is drilled with three large holes for access to the collimation screws. The counterweight is made of lead and usually stays in place, but can be easily removed with a wing nut to make it lighter to carry. This brings me to consideration of the balance point. Unlike the Dobsonian, this telescope makes use of a large but unobjectionable counterweight. The arc of swing at the bottom end of the tube must be as small as possible. The polar disk and the arc created by the declination swing are directly related: the larger the arc, the larger the disk must be. Since this is not a permanent installation and my car is not an 18-wheeler, I created an arc 12″ from the balance point, which allows me to make the disk only 30″ in diameter. A relatively simple method of determining the weight of the counterweight is to multiply each front of the tube weight by the ratio of the distance from the balance point. My finder, for example, is four times the distance from the balance point as my counterweight. If I were to add another







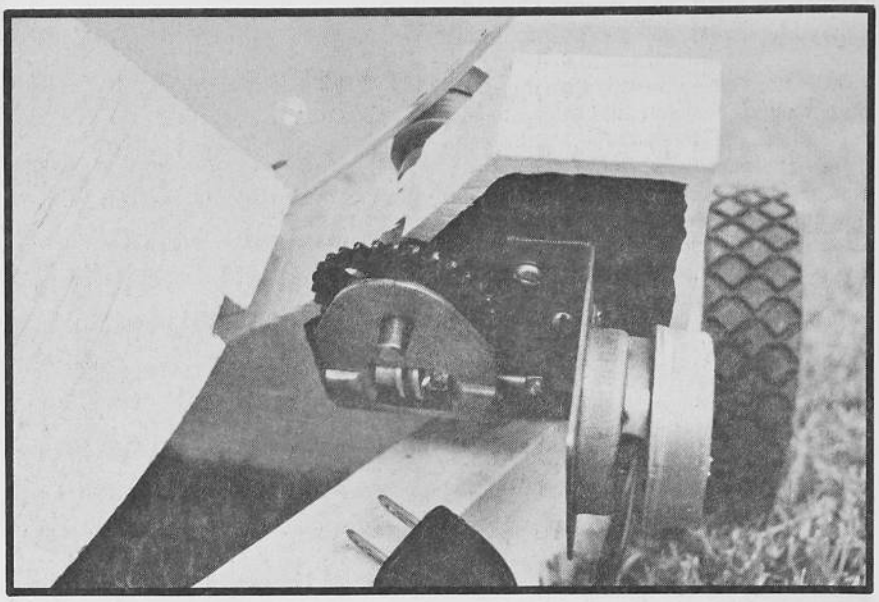
finder that weighed 10 ounces, I would have to add 40 ounces to my counterweight!

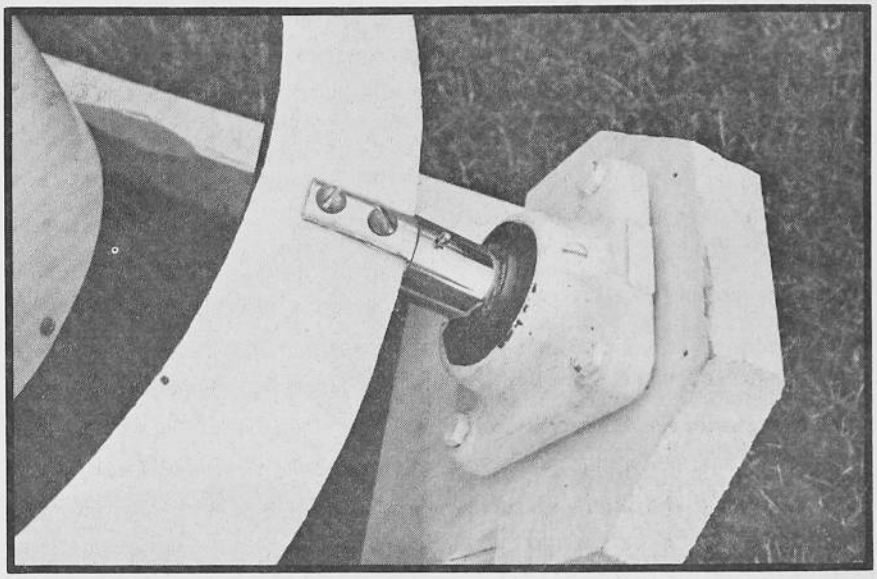
This sounds like a lot of weight, but when working with lead we found a little goes a long way. Eric Allen and I melted some lead in a skillet after we had weighed it. When it cooled, we had a large, flat weight which was easy to handle and mount. You may notice that it is not centered on the back of the telescope. The reason for this is that we balanced the tube radially as well as axially. When the tube rotates, this becomes an important consideration. Friction on the declination bearings keeps the tube from diving for the grass when I add a Nagler at the focuser. We averaged the weight of my heaviest and my lightest eyepiece and then moved the balance point just a little to compensate after the final weight was added.

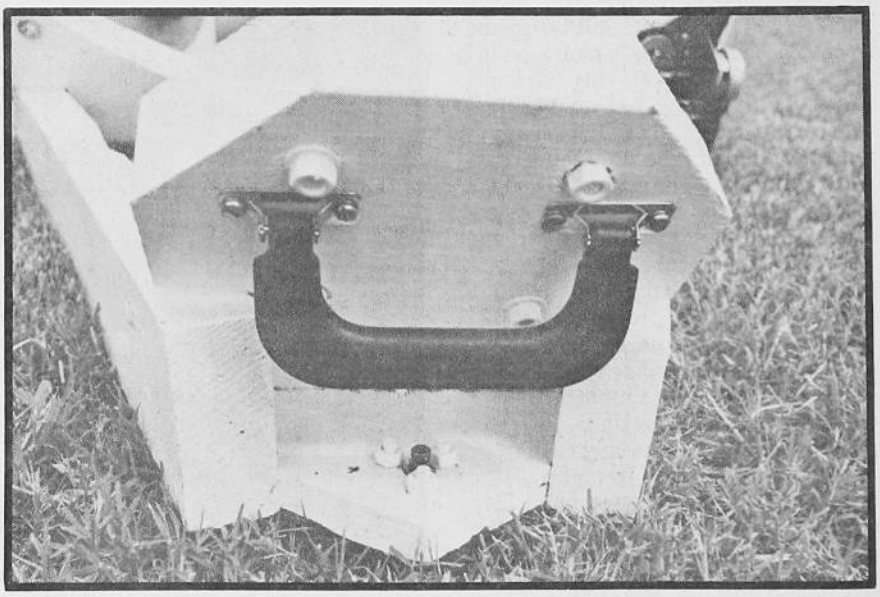
I cut the tube assembly from a piece of ¾" plywood that I found at a construction site scrap heap. I measured and re-measured exactly where the declination bearings would be, since they have to be correctly placed or the telescope won't track properly. As the circle is marked, the center point is actually your reference point for three axes: the declination axis, the optical axis, and the polar axis. In addition, it is the point from which the balance of the tube is struck. My disk is 30" in diameter with a 14" cutout for the tube to sit in.

The polar yoke is simply the bottom half of the disk re-created. Leave as much wood on the top of the disk as possible because around Polaris you'll find you need as much drive surface as you can get. I had toyed with the idea of taking the disk apart for travel but I settled on a hinged system in which two thumbscrews are the only things to tighten for set-up. It works wonderfully! The polar yoke is hinged to the polar disk with two 6" sections of piano hinge, and a 90° support is hinged perpendicular to this, locking the assembly into place.

To set up for observing, I simply tighten the two thumbscrews into place and the whole assembly is firmly locked together. The yoke is placed into a flange bearing with an attached piece of pipe along the polar axis, and the edge of the disk rides on two rollerskate wheels. On the edge of the disk, I attached a ⅛"-thick strip of aluminum for durability and to average out my sloppy carpentry. This makes a very smooth surface for driving the telescope. A lot of people are skeptical of a disk that thin, but let me explain why it works so well. If you imagine the disk assembly as a sphere with the balance point at the center, it is easy to visualize the three supports underneath. Weight







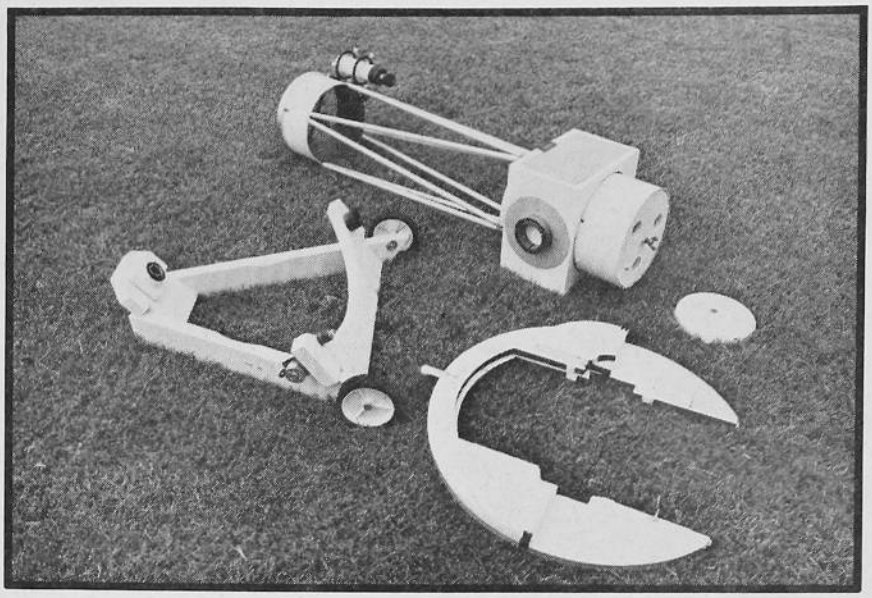
is distributed radially from the balance point to each of the supports. Since the balance point falls inside the support points, it will be stable. The key to a successful disk system is that all of the weight of the telescope is borne in the plane of the plywood and not through the face, which would bend it. There is very little flexure of the disk in actual use. What little flexure exists is compensated for because the drive and support wheels are spread far enough apart that they force the disk to "squeeze" onto the declination bearings. Remember, the edge must bear the weight, not the face!

The base is the final piece. It is the heaviest because I made it from 2x4s and sections from a 2x8. This could be lightened without sacrificing integrity. The two rollerskate wheels and the flange bearing are points of an equilateral triangle which ensures equal weight distribution and stability.

The left wheel is the drive wheel. It is $\frac{1}{24}$th the diameter of the disk, and is turned at one revolution per hour. This drives the disk at one revolution per day. When calculating the size of the drive wheel, it is much simpler — and even necessary — to use the same standard of measure for all parts concerned. For instance, I have used diameter in calculating the size of my drive wheel (30" disk divided by 24 hours requires a 1.25" drive wheel). If your drive wheel is to be turned at a slower rate, then you will have to size the drive wheel up to compensate. Turning faster, you would decrease the diameter of the drive wheel.

I picked one revolution per hour because of the parts I had on hand. I hitched a ½ rpm motor from a surplus store with a 30-tooth window crank for a one rev-per-hour drive wheel rate. (I've got a grand total of about $10 tied up in the drive system.) Mounted on the backside of the base, the 30-tooth wheel is brazed to a $\frac{5}{16}$" bolt which passes through the base and rides on two bearings (rollerskate bearings, what else!). The drive wheel (a turned-down rollerskate wheel) rides on this shaft. I simply tighten a nut down on a Teflon washer pressed between two metal washers to adjust friction on the polar axis and to keep the drive shaft turning the drive wheel.

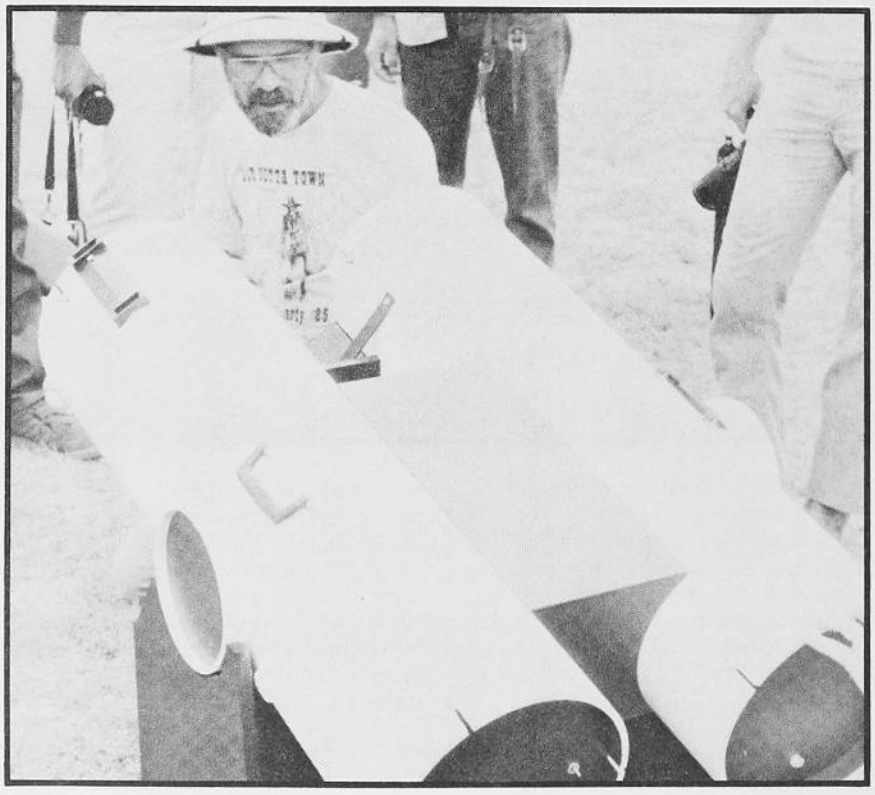
My drive, uncorrected, will track an object for about 30 minutes with a rough alignment on Polaris! I have built the angle of the wheels and flange bearing to 35.5°, which is my observing latitude. I don't have to double check my polar angle because it is built into the base. I do have a refrigerator foot on the south end for fine adjustment and because I have yet to see a level observing site. The lawnmower wheels allow me to wheel it out of the garage for casual evening observing.



This telescope serves me very well — so well that I have had several requests to build it for others. I am having mechanical drawings made up of the entire system and any TM interested in having a set can get one for a marginal printing cost. Let me emphasize a couple of things before I end: I used only hand tools in the construction of the telescope, with no machining. All of the parts are available at hardware stores, or perhaps one or two good garage sales! I love to talk about telescopes, so if there are any questions, just write me! I would like to thank Eric Allen for his inspiration and guidance. He is a man of extraordinary talent and insight, and a top-notch telescope maker.

Joe Pearson
700 Teal Place
Edmond, OK 73034

TEXAS STAR PARTY '85

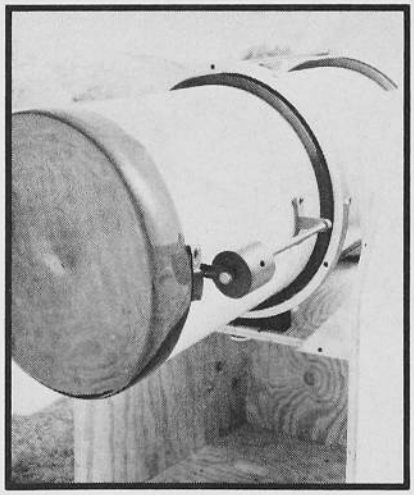


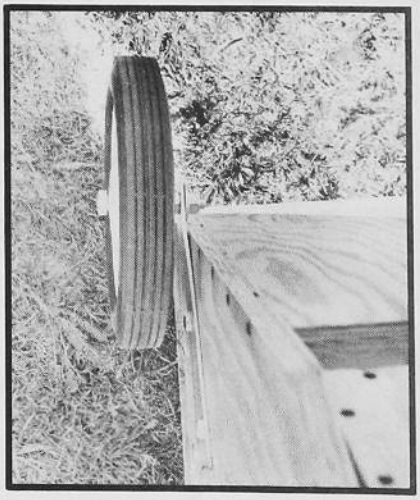
The Texas Star Party, held in Ft. Davis, Texas, is just what its name says — a star party. Several hundred dark-sky enthusiasts gather each year to observe and talk astronomy under the pitch-black skies of the Davis mountains in western Texas. Unlike older meetings such as Stellafane and Riverside, the TSP's focus lies primarily on observing. But not wholly. The TSP has also become a "proving ground" for telescope builders since it affords very dark, low-latitude skies and an appreciative gathering of telescope users.

Compared to previous years, the 1985 TSP was plagued by bad weather and a rather small turnout of ATMs. Nevertheless, several interesting telescopes and pieces of observing equipment surfaced — ranging from a binocular holder made of 2x4s and tunafish cans to a computer-controlled altazimuth 24-inch. The latter's ability to slew across the sky and place the target object within a 120x field of view was just as impressive as it sounds.

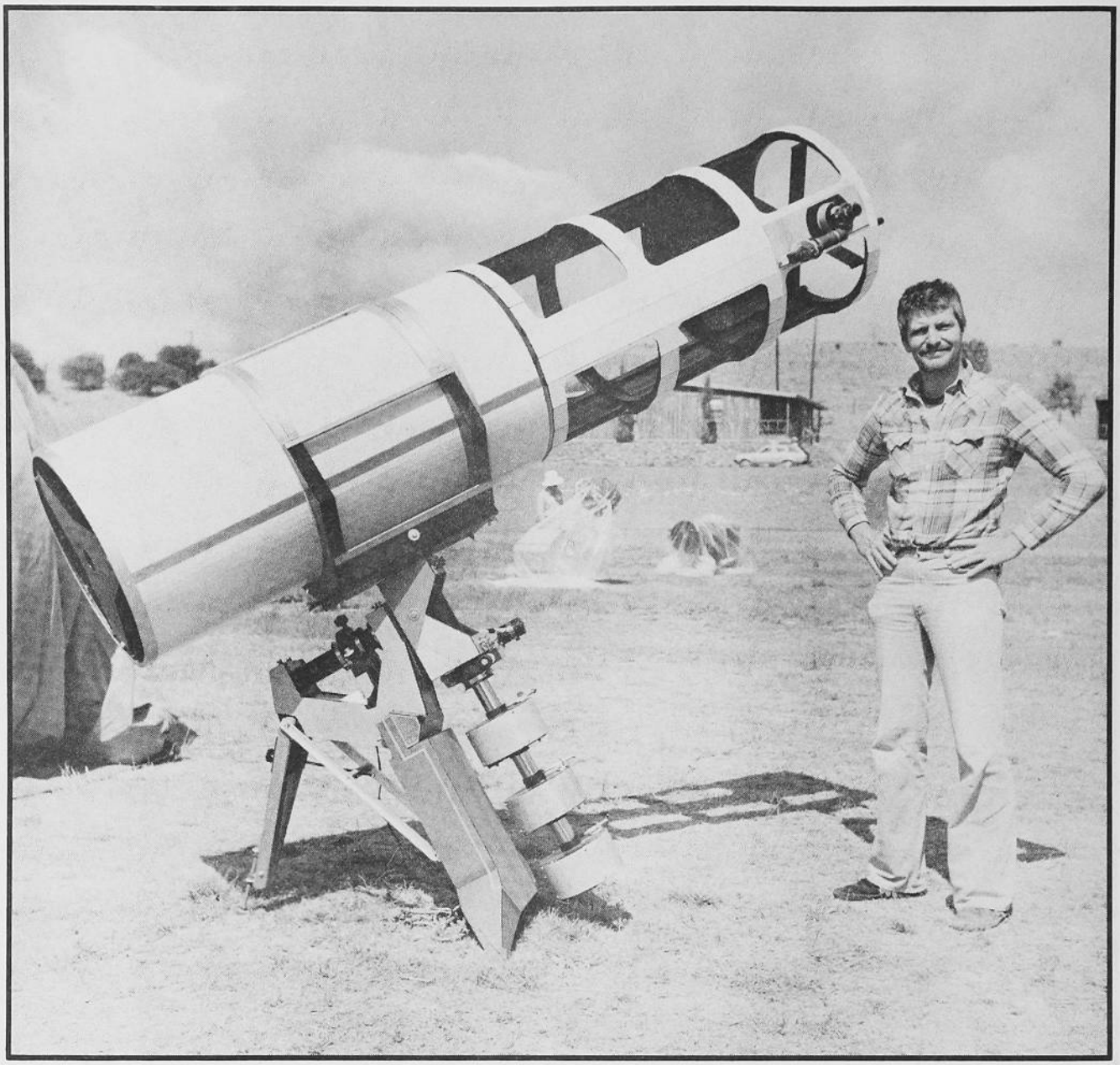
The variety of scopes may have been slim, but the workmanship and the thinking that went into the designs was quite good. *Robert Burnham*

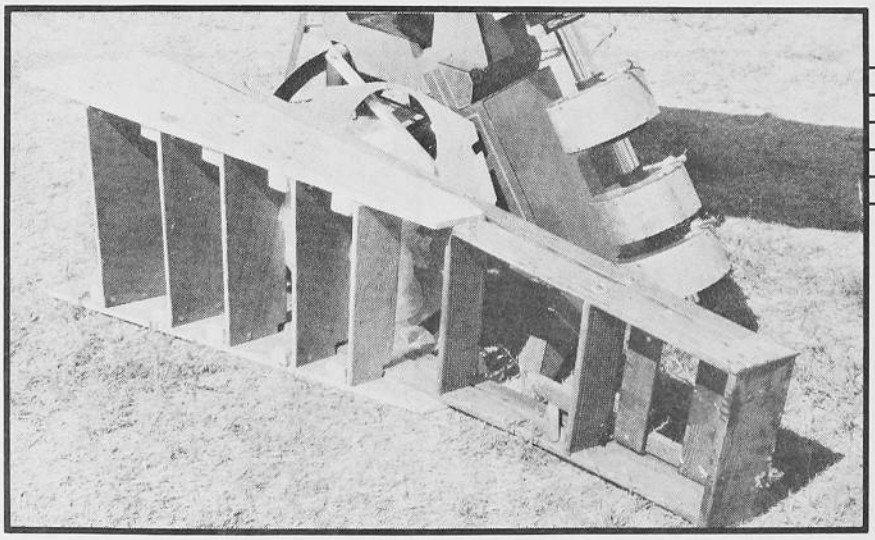
John Wagoner's 16-inch scope is a commercial/homebuilt hybrid. The tube and optics are from a Meade DS-16, but the Dobsonian mounting is homemade. Wheels make for easier transport, but John said he'd soon have to get a sturdier piece of strap iron for mounting the wheels because these kept bending. Note the triangle brace on the tube cradle, which is very important to prevent a "springiness" when you slew the scope. The rings let the user rotate the tube to whatever position is comfortable.





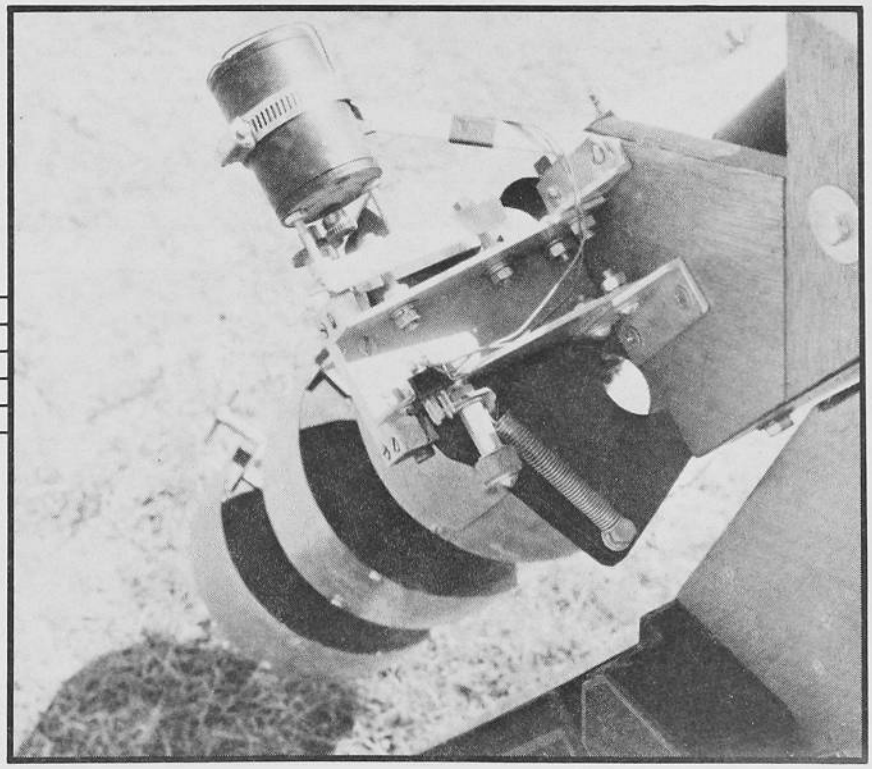
Ed Boutwell looks like he can't quite believe what he sees: a pair of 10-inch f/4.5 Dobsonian binoculars made by Lee Cain. Top: The view looking south at 3:00 a.m. The ghost in the foreground is the tent of the photographer (Mace Hooley) lit from inside (15mm lens, 40 minutes, hypered 2415).

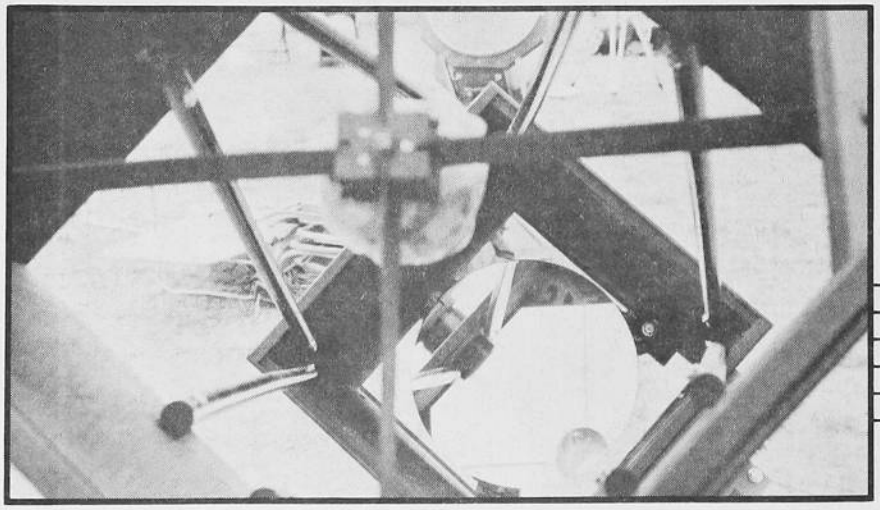




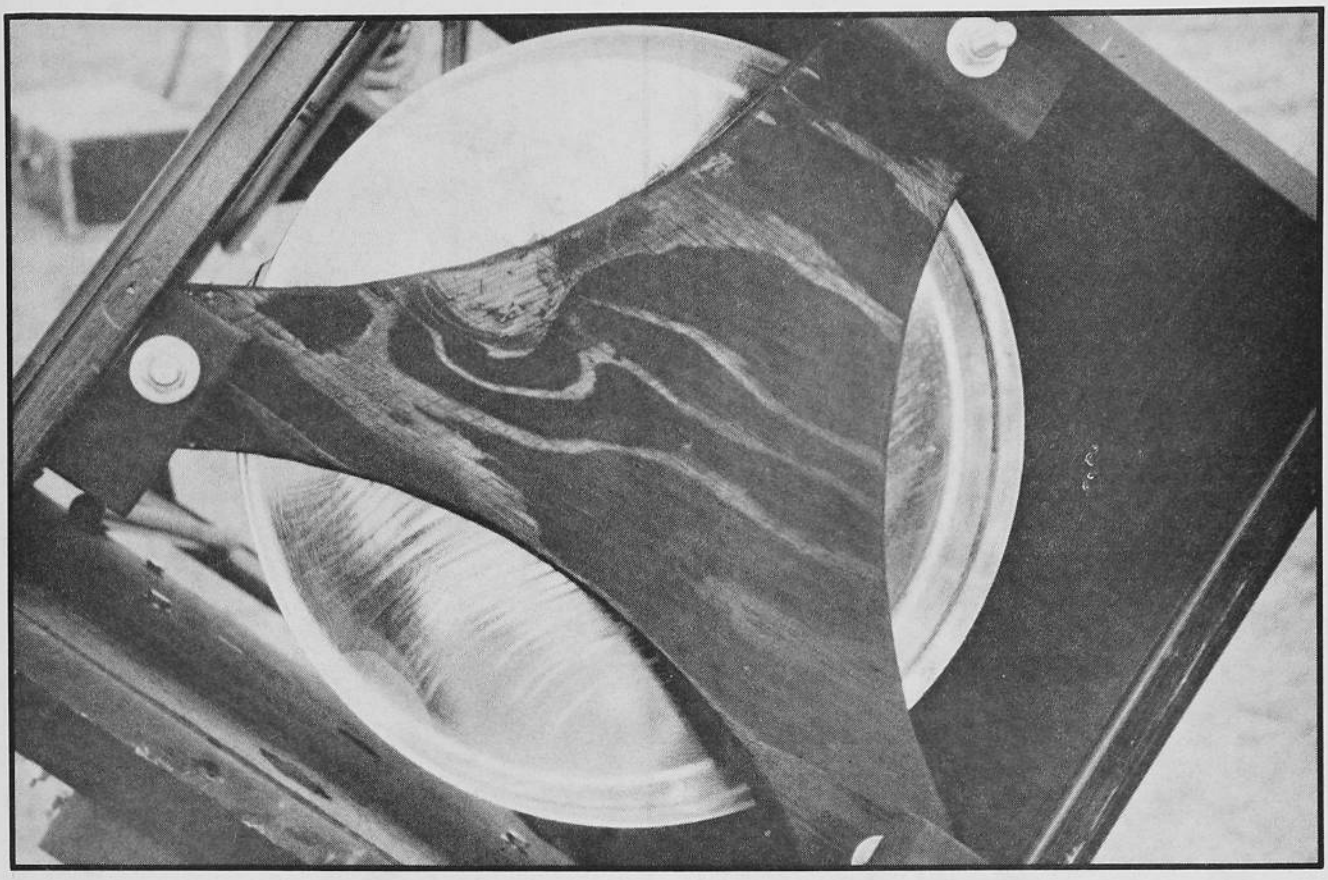
Pierre Schwar's 20-inch f/5.1 telescope sits on one of his Bigfoot mountings. Pierre ground the mirror from a 1⅜" thick Pyrex blank. The mirror is held in its homebuilt cell by two rings of aquarium cement, each ⅛" thick, placed at the 50% zone. Left: A simple modification to a wooden stepladder turns it into a handy observing accessory.

The tube on Pierre's 20-inch is kerfed masonite wrapped around plywood formers; the solid panel opposite the focuser keeps stray light from entering the eyepiece. Right: A close-up on the motor-driven declination axis.

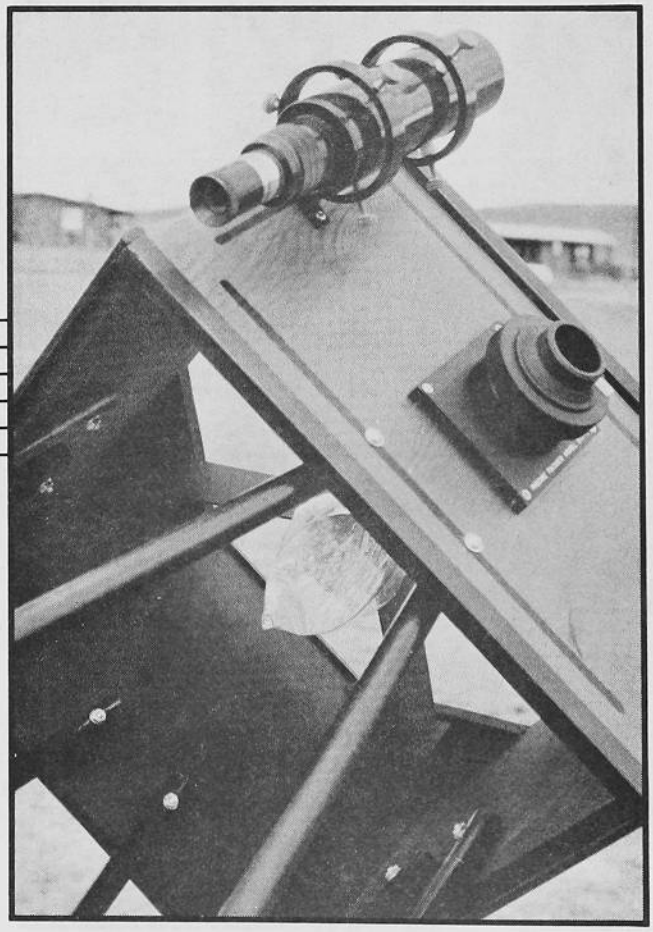


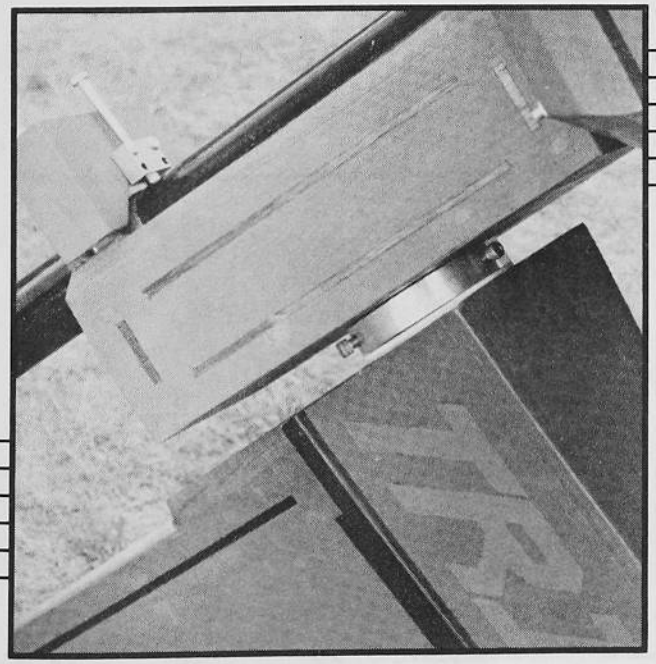


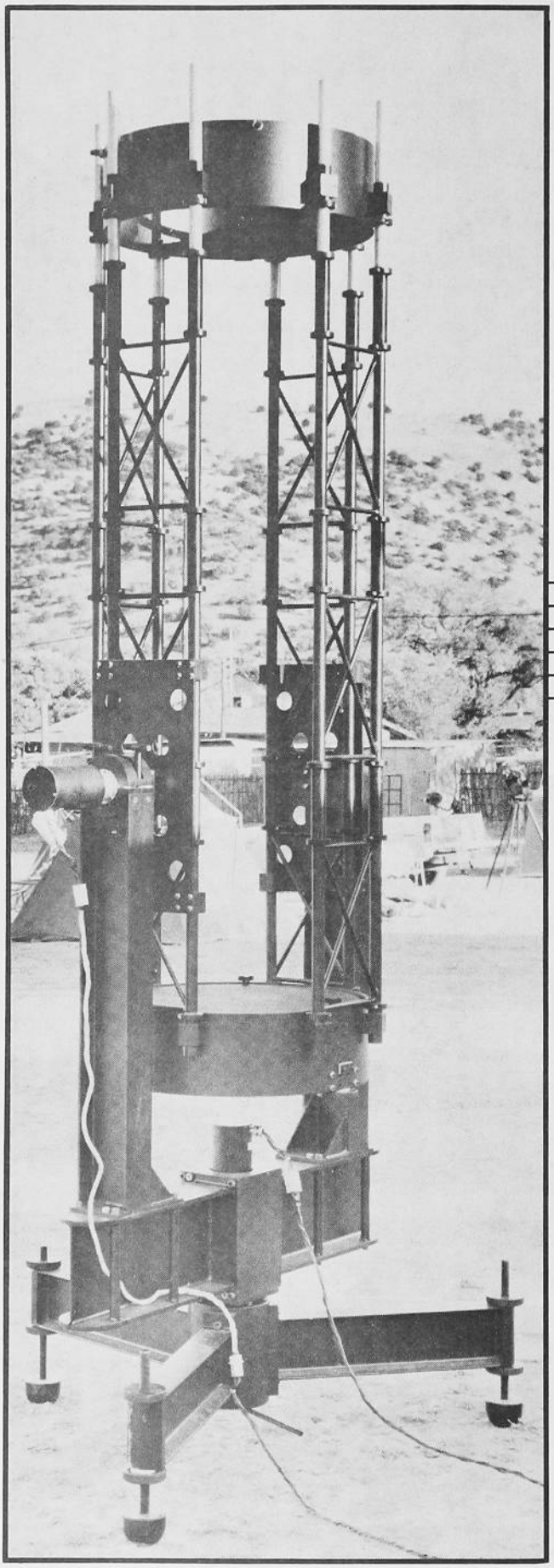
Chris Schur's "Trifid" is a 12.5-inch f/5 with a full-thickness mirror ground by Pierre Schwar, with enhanced silver coatings. The flat panels are painted "Hα" red, the telescope's name is "reflection nebula" blue, and the thin "dust lane" pinstripes are, of course, black. Left: The round struts connecting the mirror box and secondary assembly are 1" dowels.

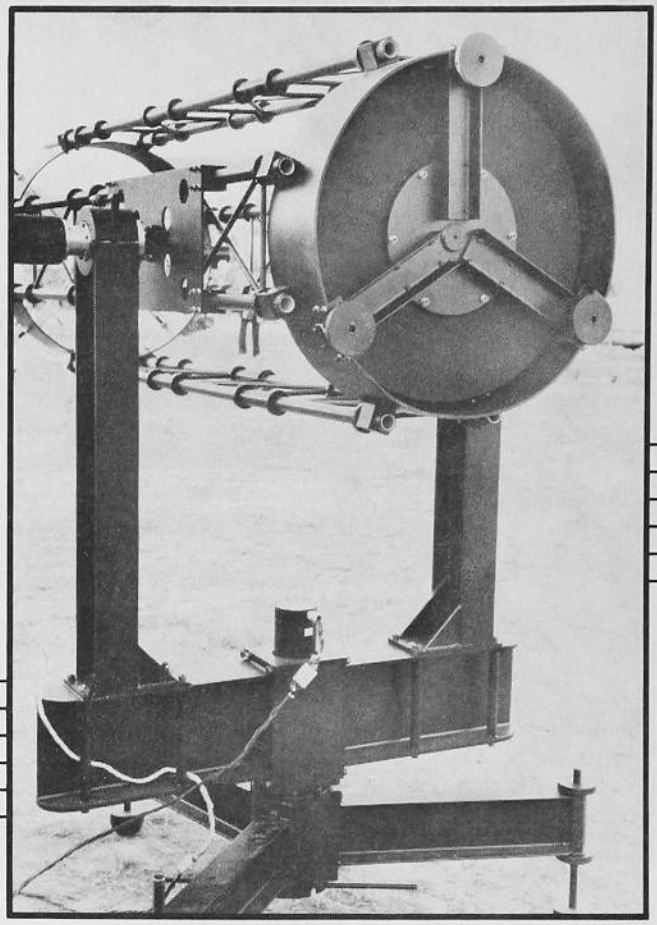


Trifid's cell is a double-thickness "Y" of ¾" plywood with spring-loaded push-pull bolts at the ends. Aquarium cement beads that are ⅛" thick are placed at the 50% zone and hold the mirror to the Y. Right: The diagonal holder and vanes are fiber glass. Below: The metal bearing on the right ascension axis and the tension adjuster on the declination axis.

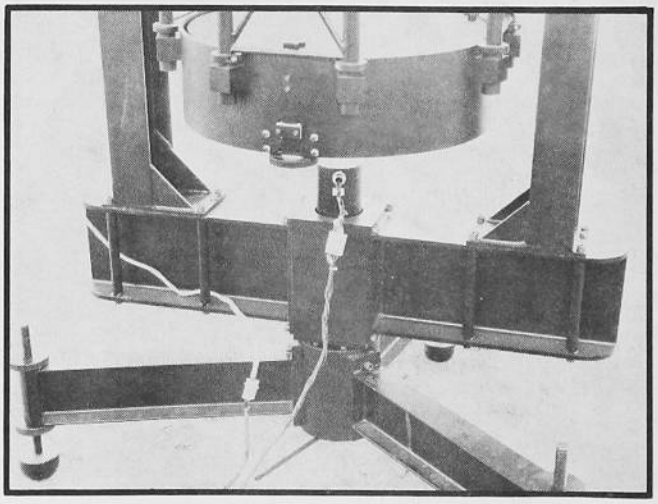


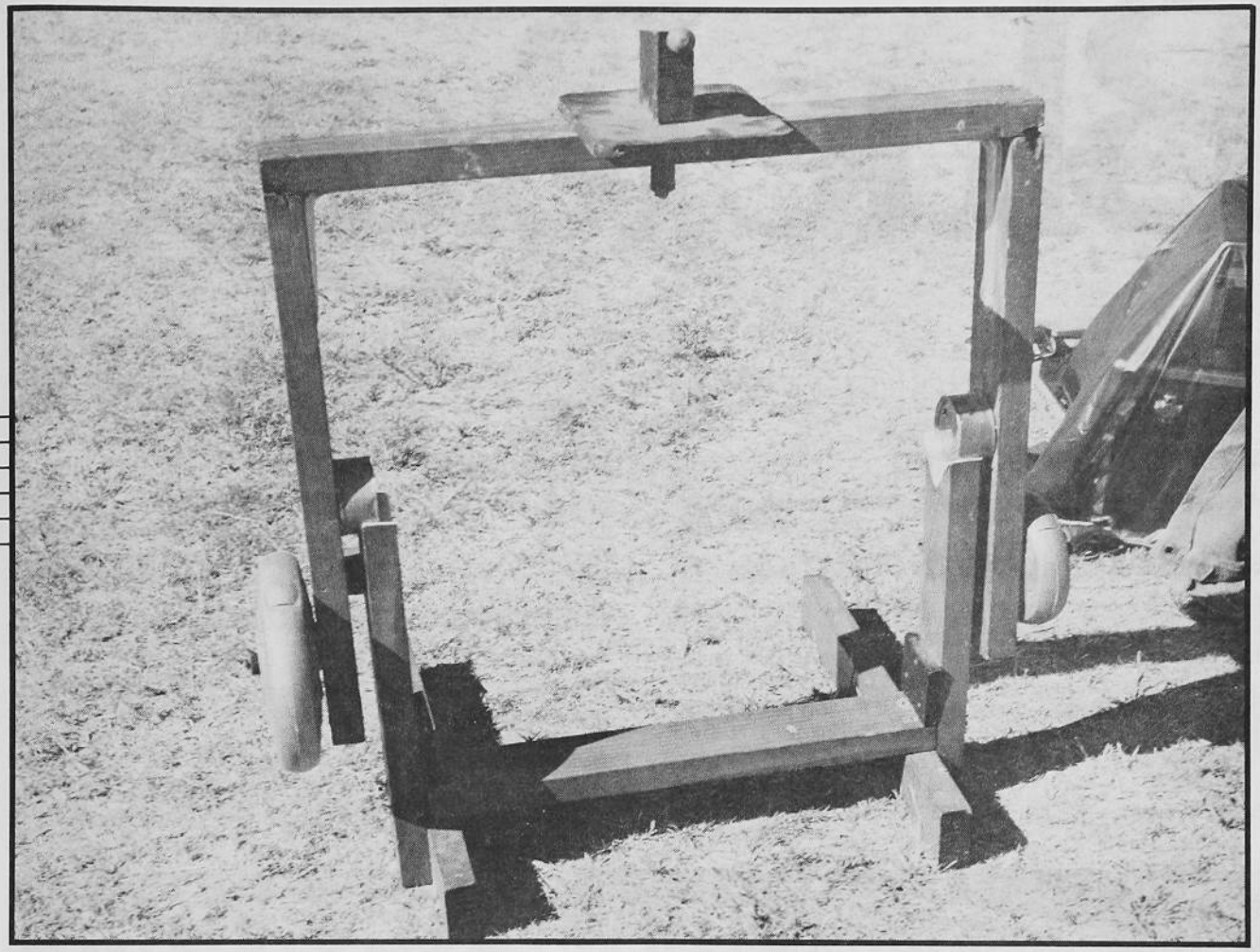


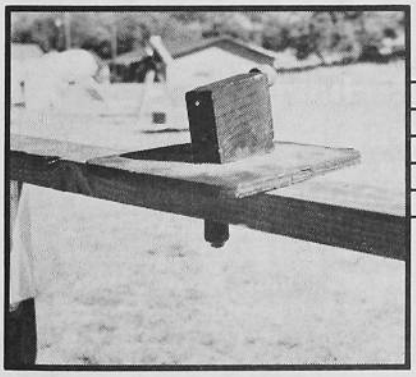


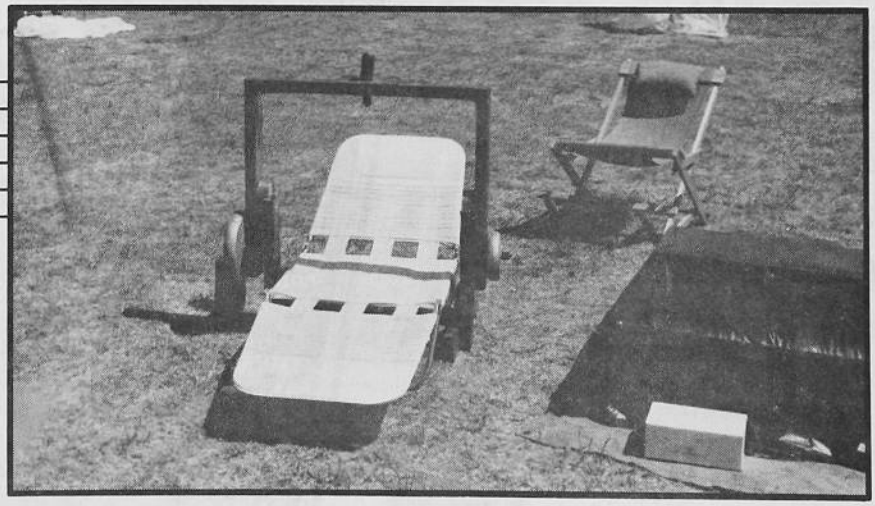


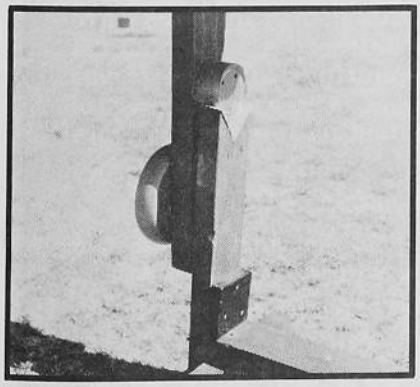
The techno-tour de force of the '85 TSP was clearly the 24-inch f/4.5 telescope from Kara Technology of Ft. Worth. A Radio Shack Model 100 portable computer contained the drive software and database of objects to observe. The Model 100 had 1,000 objects in the database; other computers could allow more. Each time the telescope searched an object (by name or celestial position), it would swing up to point at the zenith, rotate to the correct azimuth, and swing down to the correct elevation. The average time for finding a new object was about 10 seconds.











And in the low-tech corner, we find this handy binocular holder by Mike Planchon. The bearings are tuna-can-on-Teflon, the main materials are 2x4s, and the counterweights are 5-pound barbell weights. Center left: The binocular platform has a ¼-20 bolt to hold the center shaft of Mike's 11x80s, and the platform itself pivots left and right. Mike said the weakest link in the whole thing was his awkward lawn chair, which had a backrest that seemed to have a mind of its own.

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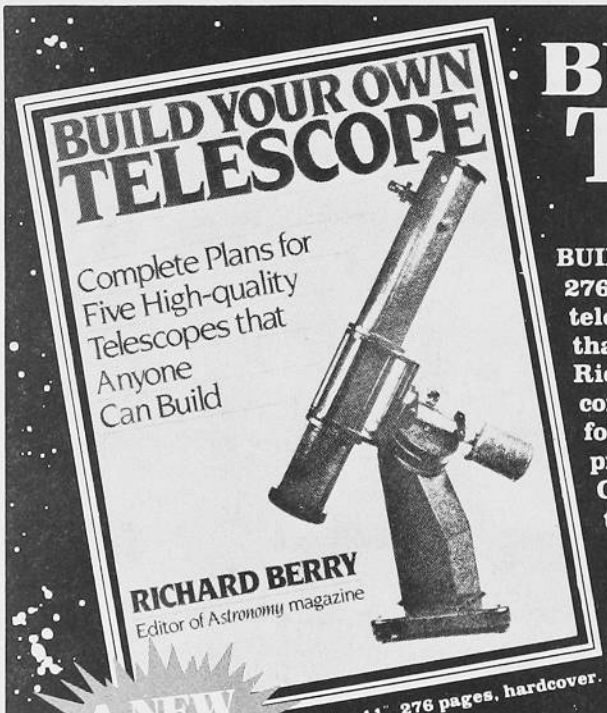

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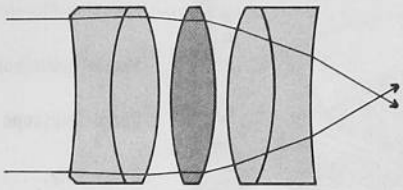
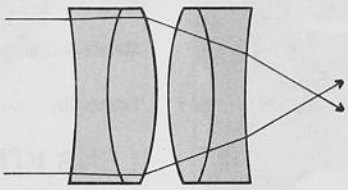
Design Specifications: Meade Series 4000 eyepieces yield the widest possible fields of view, consistent with pinpoint edge-of-field sharpness and long eye relief, and yet with extremely low astigmatism, spherical aberration, and off-axis color. Incorporating 7-layer multi-coatings and edge-blackened optics for optimal image contrast, these sophisticated 5- to 8-element designs permit levels of optical corrections virtually impossible to achieve with eyepieces of fewer elements. The polished chromed-brass barrels are threaded for standard filters, and, where practical (see table), eyepieces and both Barlow lenses are parfocal, allowing eyepiece interchangeability without refocusing.

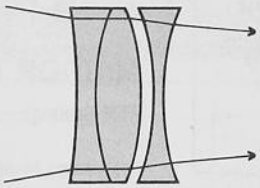
Eyepiece Groups: Eighteen focal lengths in the three Series 4000 eyepiece groups permit precisely the right eyepiece for any application. Whether your telescope is an f/4 Newtonian, an f/10 Schmidt-Cassegrain, or an f/16 refractor, its performance will benefit by using these incredible oculars:



Meade 5-element Super Plössl design: the central lens element enables significant reductions in chromatic aberration and edge-distortions over other premium Plössl designs.



Other premium Plössls: include only the traditional 4-elements.



Meade Series 4000 Barlows: 3 elements, air-spaced, instead of the standard 2 non-air-spaced elements.

Series 4000 Eyepieces and Barlows

Super Plössls (5-elements)	APPARENT FIELD	BARREL DIA.	PARFOCAL
6.4mm	52°	1¼"	Yes
9.7mm	52°	1¼"	Yes
12.4mm	52°	1¼"	Yes
15mm	52°	1¼"	Yes
20mm	52°	1¼"	Yes
26mm	52°	1¼"	Yes
32mm	52°	1¼"	Yes
40mm	44°	1¼"	No
56mm	52°	2"	No
Super Wide Angles (6-elements)			
13.8mm	67°	1¼"	Yes
18mm	67°	1¼"	Yes
24.5mm	67°	1¼"	Yes
32mm	67°	2"	No
40mm	67°	2"	No
Ultra Wide Angles (8-elements)			
4.7mm	84°	1¼"	Yes
6.7mm	84°	1¼"	Yes
8.8mm	84°	1¼" & 2"	Yes
14mm	84°	1¼" & 2"	No
Barlow Lenses (3-elements, air-spaced)			
#140 2X Telenegative Amplifier		1¼"	Yes
#142 2.8X Telenegative Amplifier		1¼"	Yes

Meade 2" Mirror Diagonal: For attachment to Schmidt-Cassegrain telescopes, the 2" Mirror Diagonal permits use of Series 4000 eyepieces with 2" barrels. The 1/10-wave-flat Pyrex mirror, manufactured at the Meade Costa Mesa optical facility, is multi-coated with enhanced aluminum for maximum reflectance. An adapter for 1¼" eyepieces is included.

Where To Buy: Meade Series 4000 eyepieces and Barlows are available from over 600 authorized Meade dealers in the U.S.A. and Canada. Call us toll-free (see below) for your nearest dealer.

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Warranty: All Series 4000 systems are covered by the Meade Limited Lifetime Warranty—the most extensive in the industry. See the Meade catalog for details.

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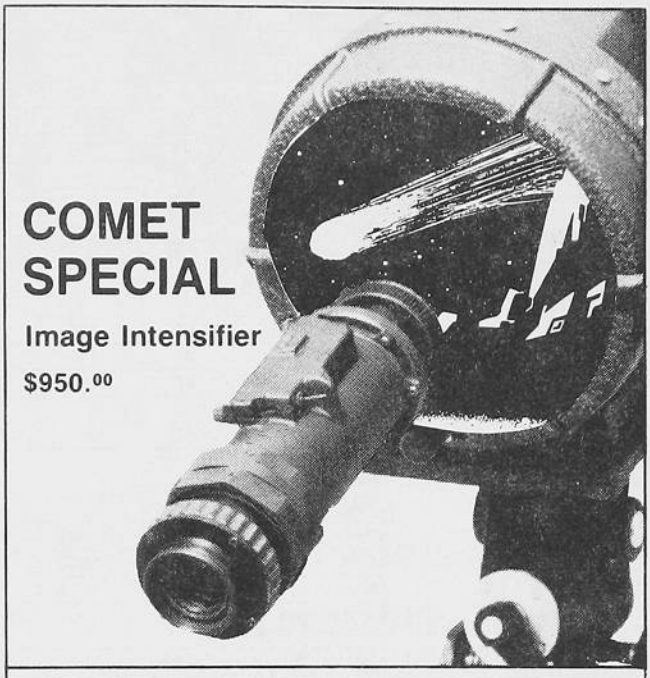

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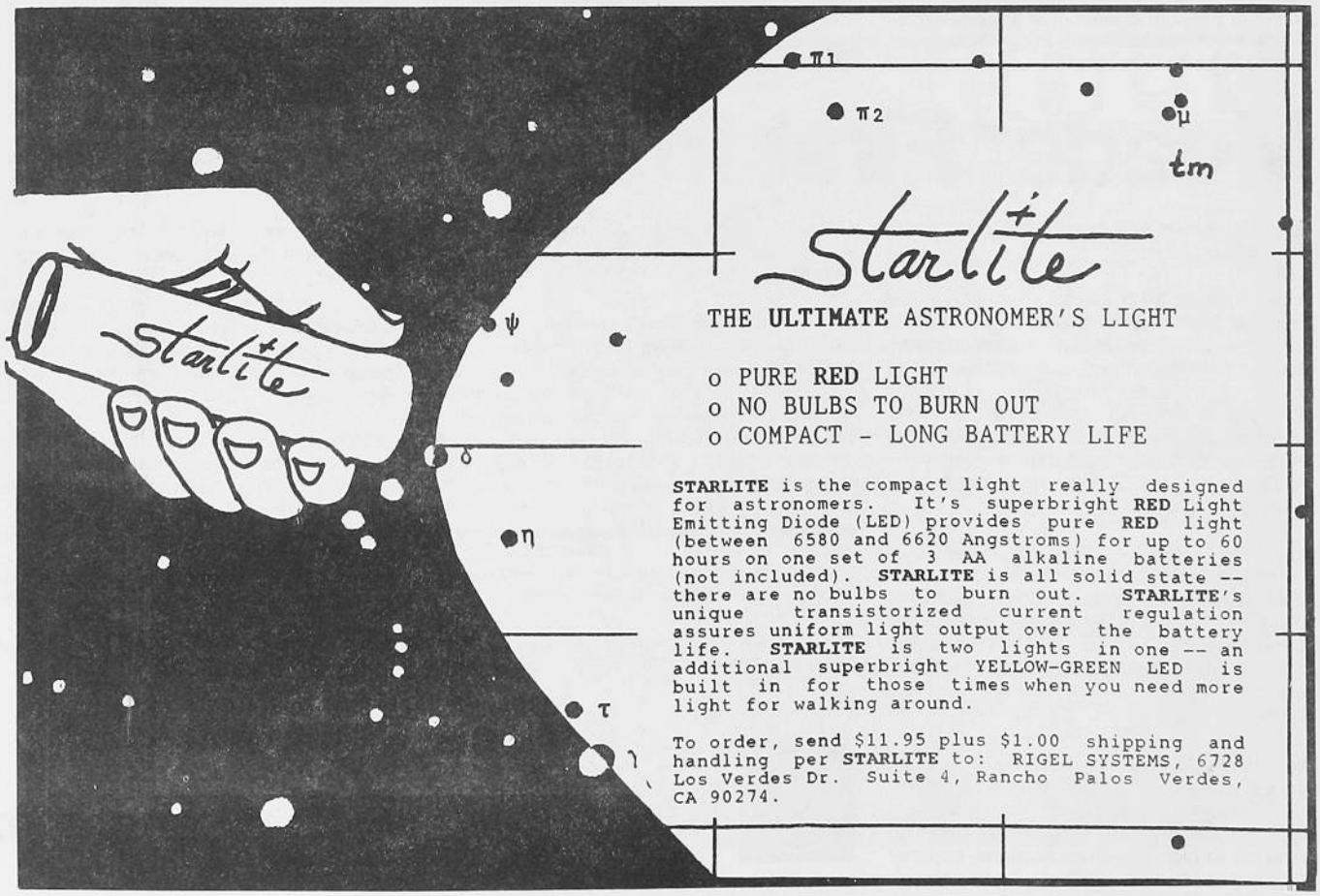

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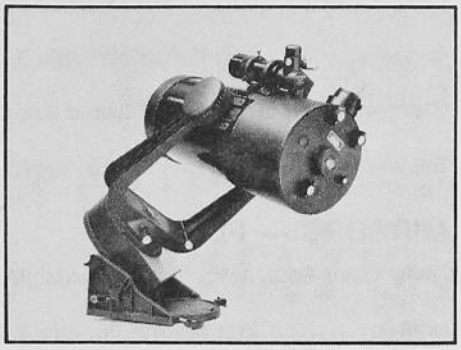

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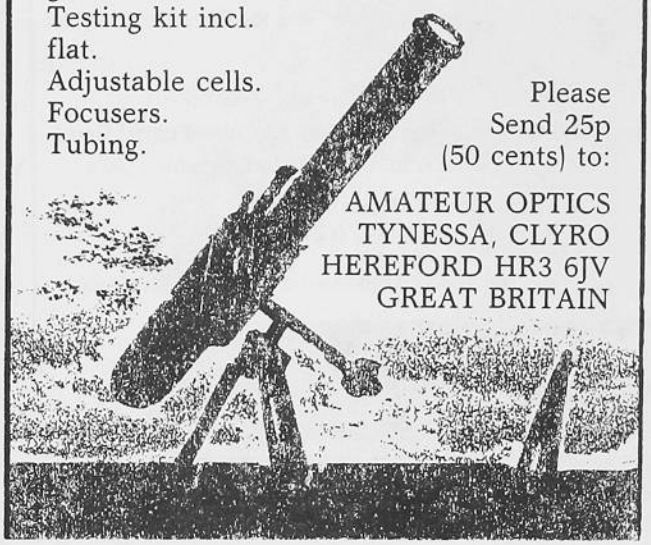

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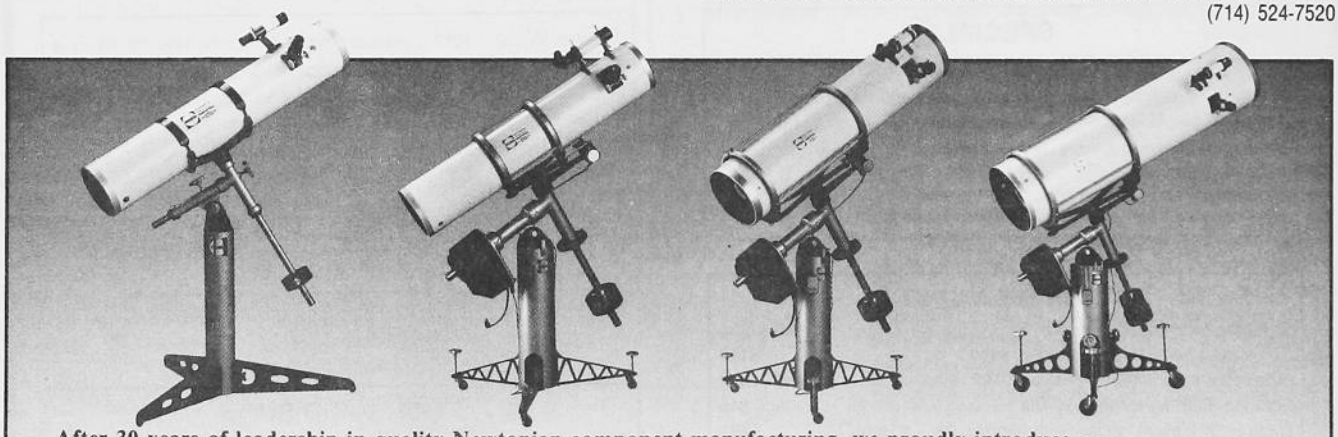

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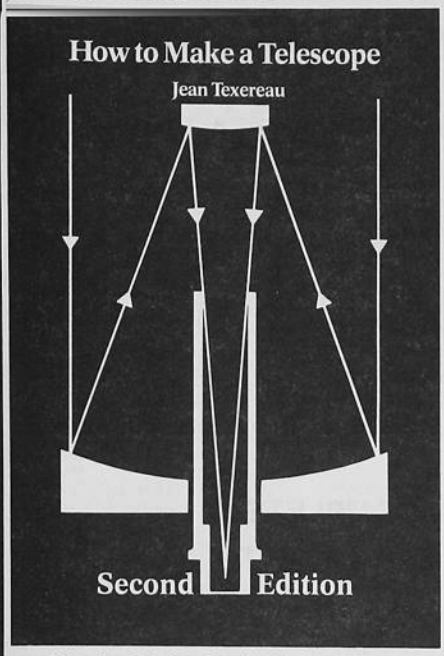

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From the Foreword to the First Edition
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Editor: *Amateur Telescope Making I, II, and III.*
Scientific American magazine

I owe a lot to the first edition. My first mirror, begun when I was 13 years old, was a trial and error effort, and indeed, the whole project might have ended in failure had a local telescope maker not taken the time to show me how to parabolize it. My second mirror was figured to a fine paraboloid, finding Jean Texereau's book made all the difference. Since those first mirrors, I have gone on to make a dozen more, taught mirror-making to others and built many telescopes, but I still turn to Texereau.

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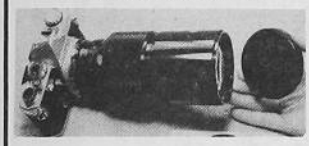

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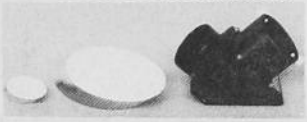

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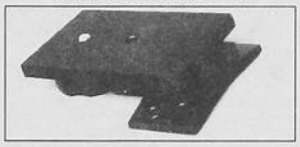

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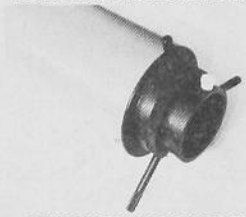

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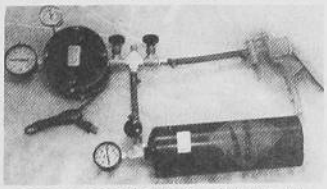

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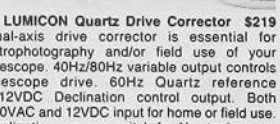

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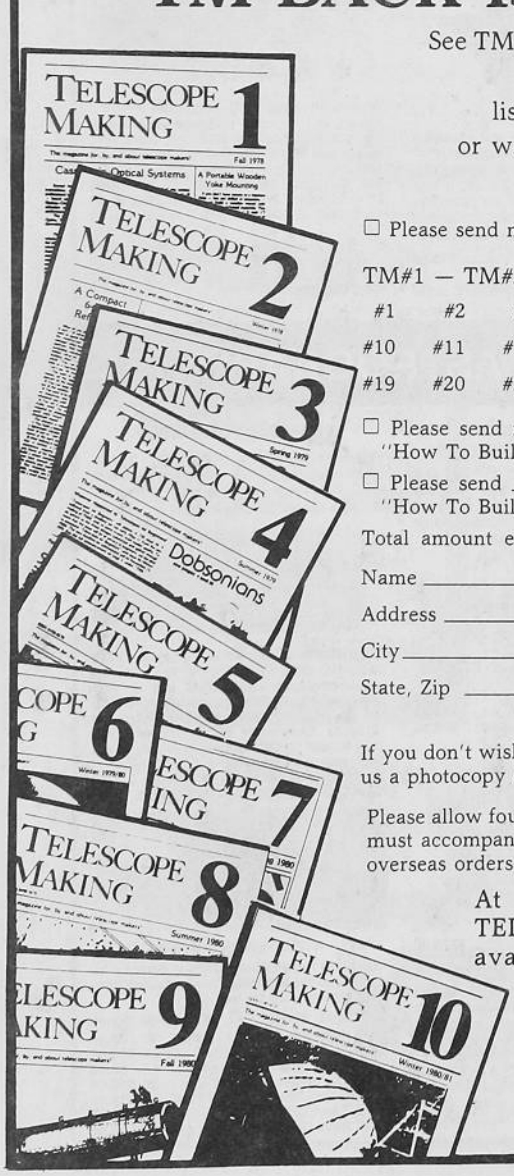

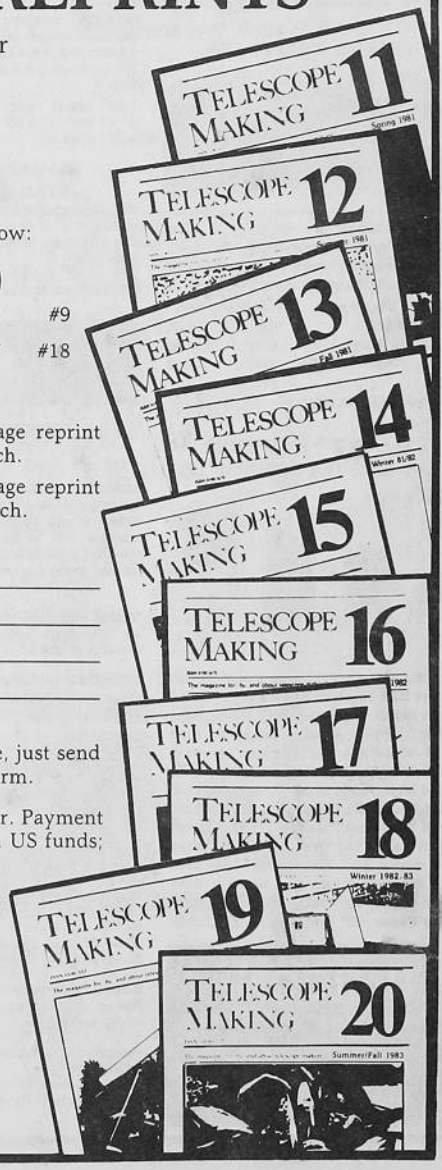

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